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DO YOU KNOW . . . .

► . . . . That membership in the Society is really everyone's business? Organized activities are the responsibilities of two committees, but membership is the business of every member of ASEE; it is his enthusiasm, interest, work on committees, and attendance at meetings that convinces others that they should belong. The Committee of Young Engineering Teachers is again sponsoring a major drive, paying particular attention to the schools at which there was little or no increase in membership last year. The Industrial Membership Committee, through various programs, has been able to achieve a gradual increase in that type of membership and will increase the tempo of its activities. The special reports of the Society also are important factors in promoting membership. Those reports benefit the entire profession and every engineering teacher should be familiar with them. On page 192 there is a membership application form; give it to one of your associates and see that it is returned to the Office of the Secretary. If each member does his part, ASEE will continue to grow in membership, in activity, and influence. So get that new member now!

► . . . . That the Technical Institute Division has prepared a new booklet called "The Engineering Technician"? This is a completely new publication replacing an older one. An indication of its wide acceptance is that over 35,000 copies were distributed in three months. Single copies are available from the Office of the Secretary for 25¢ each. Quantity orders for 100 or more copies should be directed to the Editor, Technical Education News, 300 West 42nd St., New York 36, N. Y. One hundred to 4,999 copies cost 10¢ each; 5,000 to 14,999 copies cost 9¢ each and 15,000 and up copies cost 8¢ each.

► . . . . That the "National and International Aspects of Systems of Units in Coordinated Disciplines of Science and Technology" is the theme for the Section M—Engineering program for the annual meeting of AAAS? The meeting will be held at the Hotel Statler in Washington, D. C. on December 29 and 30. The program will present a clear-cut picture of the systems of measurement now in use in the various parts of the world and the need for clarification and understanding to permit a greater interchange of knowledge to aid and assist industry and commerce. Detailed programs may be obtained from the Secretary, Section M—Engineering, c/o Engineers Joint Council, 29 West 39th Street, New York 18, New York.

► . . . . That the EJC Engineering Manpower Commission's placement survey indicates that only 9.8% of last June's engineering graduates plan to enter graduate schools? This includes the high of 15.8% for Chemical Engineering. The precentages for other areas are 11% for business administration, 24% for liberal arts, and 29% for the physical sciences. These figures substantiate the contention of CDEF that one of the difficulties with the future supply of engineering teachers is getting the good students into on-campus graduate study. There are unique features influencing the percentage for engineering graduates, but it is very clear that one of the tasks for all is to sell more students on the idea of graduate study. The report, made during May, concludes, "If these results are even remotely representative, it is apparent that within the last month of the aca-

demic year engineering graduates were all able to complete their plans for post-graduate activities."

► . . . . That Engineers Joint Council is now incorporated? A majority of the member societies of EJC has approved the new constitution, and EJC is now organized in accordance therewith. Mr. E. R. Needles of Howard, Needles, Tammen, and Bergendoff, of New York City, is the President. The Board of Directors of EJC also has confirmed the election of the American Institute of Plant Engineers as an associate member, bringing the number of societies in EJC to nineteen.

► . . . . That the Survey of the Engineering Profession is now under study by the Ford Foundation? The original 1956 ECPD–EJC report and the reports submitted last year by the Bureau of Applied Social Research of Columbia University both have been discussed with representatives of the Foundation.

► . . . . That the National Education Association plans to alternate its nation-wide studies of salaries and need for competent personnel? The salaries study will be reported in even numbered years and the personnel report in the odd numbered years. Each study will be started soon after the opening of school in September and the final reports will be scheduled for publication in March.

► . . . . That the President's Committee on Scientists and Engineers is continuing its activities for local action? Last July the committee started publishing a monthly news letter entitled "Local Action." If you want to get on the mailing list write to the President's Committee on Scientists and Engineers, Washington 25, D. C. The committee is also continuing its distribution of "Local Action Kits," which contain selected literature related to science and mathematics teaching. The kit is kept up to date through regular mailings as fresh materials become available. Information on community programs is kept current through questionnaires aimed at determining the nature and scope of programs and community response. Because of budgetary limitations, distribution is limited to groups rather than individuals.

► . . . . That there is a completely new staff at NSF dealing with engineering research? Dr. G. M. Nordby has become Head of Civil Engineering at the University of Arizona, Dr. R. N. Faiman is leaving in January to become Dean of Engineering at New Hampshire, and Dr. R. H. Long, Jr. now is Professor of Mechanical Engineering at the Illinois Institute of Technology. The new Program Director for the Engineering Sciences is Dr. A. H. Waynick, on leave of absence as Head of the Department of Electrical Engineering at Penn State. Also new are Dr. J. N. Reeds, on leave from the Chemical Engineering Department of the State University of Iowa, and Dr. Kenneth Picha, on leave from the Mechanical Engineering Department of Georgia Institute of Technology. In the higher echelons are physicists, Dr. R. M. Robertson, formerly with the Office of Naval Research, now the new Assistant Director for the Mathematical, Physical, and Engineering Division, Dr. R. B. Brode, now Associate Director for Research, and Dr. A. T. Waterman, the Director.

THE PROBLEM OF POTENTIALLY GIFTED FRESHMEN

JOHN A. HENRY

Professor of Mechanical Engineering
University of Illinois

Presented to the Educational Methods Division at the Annual Meeting at Berkeley. Recommended for publication by that Division.

Over a period of years there has been an increasing interest in the fate of the student of superior ability. With the current hysteria generated by launching of Sputniks and Explorers, those of us who have been concerned over the years can choose either to say "I told you so," or in some cases we may wish to withdraw from the fray on the grounds that the majority is always wrong.

When the subject of superior students has come up, each of us has heard, and many of us may have uttered, that idiotic bromide, "You can't spoil the good man." Is this true? Is the truly superior person unspoilable, or is this attitude an easy excuse for evading an issue of real importance? Of course, before answering the last question, we must define the superior person. As instructors, we are apt to react differently than as researchers or philosophers. We can be objective here today, but in the classroom we will continue to classify the mediocre and poor grade-getters as either nitwits or rascals.

Definitions

What are the criteria of a superior student? We may be able to agree that he is a person of high ability, high performance and stable personality. Neither lazy genius nor persistent mediocrity meets the test. Nor does the bright person with a disabling neurosis satisfy us.

What is a potentially gifted student? We shall define him as one with high native ability who may or may not enjoy the blessings of performance unmarred by background, poor motivation or personality disturbances. There are far more potentially superior persons than the few who go the whole way.

A great deal of work with superior students has been done at the Junior-Senior level at various institutions. Two years of tough competition have allowed the superior men to float to the top of the heap, although it must be admitted that the high grade-point bracket includes mediocre perfectionists and a scattering of poorly adjusted persons. Far below these top performers are a number of potentially gifted men who have slipped down to mediocre performance or to academic failure. On the whole, a special program for these latter should be reasonably successful.

Questions and Answers

If we think of a special program for the potentially gifted men, we must ask some questions.

1) Can we define these men?

2) Should we be concerned as college teachers and administrators about those factors which apparently cause the potential genius to fade? Should we try to overcome the handicap of indulgent or harsh parents, of smugness, of intellectual immaturity, of basic insecurity, of over-socialization and so on?

3) Can we do anything about these handicaps if we turn our hand to the job?

Let us take up these points one by one.

1. We *can* define potentially gifted students. A good test of native ability, such as the ACE or the SCAT, will do the trick to a degree. The ACE (American Council on Education) test and the newer SCAT (School and College Ability) test have been used at Illinois for many years. They are divided into a quantitative (Q) or mathematical reasoning portion and a linguistic (L) or word reasoning portion. There is also a totals (T) score for the combination. There are national norms for each of the tests, but at Illinois each college has its own norms, revised at frequent intervals. Thus a ninth or top decile in this discussion means the top ten per cent of T scores among entering freshman engineering students.

High school ranking has been universally recognized as a reliable predictor of college success. It has recently become fashionable to write off high school experience as unrealistic, but the fact remains that this factor does have significance, despite the wide diversity of preparatory programs. To a degree, high school performance is an indication of motivation.

For the past four years, a placement test in mathematics has been administered to many of our incoming students. Exceptions are those who enter with college credit from some 31 high schools of the state and those whose mathematical preparation is too weak to justify the test. The principal, or Analytic Geometry placement test consists of sixty items, and has proven to be an excellent indicator of progress in engineering at Illinois.

Correlations have been run on these three predictors with first semester and fourth semester grades. A comparison of these predictors with fourth semester status has also been studied. As another measure of performance, success has been defined as being on clear status at the end of the fourth semester, previous studies having indicated that 90 per cent of these "successes" will graduate. Table 1 shows the results of these predictions for the entering class of September 1954.

Finally, a multiple regression equation was worked out for the 697 freshmen entering in 1954, giving a predicted grade point average at the end of one semester:

$$\text{First Sem. GPA} = 0.01244\,(\text{HS-\%}) + 0.3152\,(\text{ACE Total-Decile}) + 0.0305\,(\text{Anal. Geom.-Raw Score})$$

TABLE 1

	High School Rank		ACE		Math. Place	
	Started	% Succ.	Started	% Succ.	Started	% Succ.
Deciles 9, 8	259	45	126	44	92	63
7, 6, 5	251	22	200	34	150	36
4, 3, 2	107	11	196	22	157	15
1, 0	18	11	114	13	79	14
Totals	636	29%	634	29%	476	31%
Corr. with 1st Sem. Grades		0.453		0.316		0.483

2. Should we be concerned about the potentially gifted? If the human mind is the most precious of our natural resources, and if cultivation of the mind is the primary function of an educational program, we must admit that we do have a responsibility for all the potentially gifted students. High mental ability is in short supply, and will be increasingly important as our civilization increases in technical and social complexity. We have an obligation to take the raw material that comes in the doors of our institutions and to do the best we can. If this material has flaws, we must strive to rework it into salvageable shape. We cannot send it back to the vendors and ask for a new shipment, for in general, there is no more to ship. If these men do not belong in engineering, we have an opportunity and an obligation to see that they do not just fade away.

3. As for the third question, there is no clear-cut statistical evidence that we can do a significant salvage job. Neither can we say that it is impossible. This is the area we are seeking to explore in our counselling program for the potentially gifted freshman.

The Plan

For the past three years, the Department of Mechanical Engineering has been trying to reach the potentially gifted freshmen. As soon as the freshman guidance examinations are available, men who have scored in the 9th or top decile on the ACE (now the SCAT) test and who have indicated a preference for mechanical or industrial engineering are identified. They are sent individually typed letters of invitation to a group meeting by the head of the department. This letter explains the general nature of the program, including the fact that it is experimental and voluntary.

At the group meeting, the department head presides, and introduces in turn faculty members who cover the several aspects of the overall picture. Briefly, these are:

1. Nature of the problem and program,
2. Scholarship and graduate work,
3. Scholastic honoraries and student society branch activities,
4. Scholarships and financial assistance,
5. Registration procedures and proficiency examinations,
6. Summary including the hope that these selected students will take advantages of proficiency examinations, full or heavy schedules, special programs, etc.,
7. Assignment of a special advisor for each man among the faculty men on the program,
8. An invitation or request for each man to make an appointment through the Student Counselling Service of the University with a specified faculty man. In this case, the problem is simplified because the writer is a quarter-time Counsellor with the Student Counselling Service.

During the counselling interview, which lasts an hour, the student fills out forms that tell as much about the man as a faculty advisor could wish, covering high school subjects taken, activities, family background, financial status, hobbies and interests, and so on. This is supplemented by oral discussion of the motivation and aspirations of the student. Potential and present problems are uncovered here. Should referral to the professional services of the Student Counselling Service be indicated at this time, it is suggested to the student. Results of the freshman guidance examinations are discussed.

All material from the interview is stapled into a manila folder and sent to the permanent faculty advisor for

the student. The student is urged to make immediate contact with the advisor, if for no other purpose than to get acquainted.

Follow-up

Subsequent contacts are made through the special advisors, who will see the man at least once a semester during the pre-registration procedure and more frequently if the student seeks special advice. It should be emphasized at this point that the advisors have been nominated on the basis of their demonstrated interest in the welfare of students, and of course this is a voluntary activity. Evidence seems to indicate that these men appreciate the contact with the students at this early stage and take genuine interest in their progress.

The problem of special programs and proficiency examinations is not yet solved. The thinking of the advisory group is simple. "Is the student trying to get into something special, or trying to get out of something routine?"

In the first semester, special programs for able students are routinely available in mathematics, rhetoric and chemistry. Unfortunately, we do not see these potentially gifted men until after their class work has started, so we have no control over their initial registration where speed-up is most feasible. A move to pre-enrollment counselling is indicated.

For the next three semesters, there is little room for maneuvering. In general, students are reluctant to leave the beaten path, and it takes real persuasion to convince some that they should take an individual path even in the last two years.

Results

The first or 1955 group is just completing the junior year. It must be confessed that, statistically, we are not yet able to point to any significant improvement in staying power or scholastic average. At this point, the sample is too small to do so in any case. When we are ready, we will have as controls previous students in mechanical and industrial engineering of the same level of ability as well as those in the other departments of the College. Contact with these young men has intensified the interest of the participating faculty, and fostered a desire to do a better job in the future.

It has been felt that several students have been salvaged who might have gone down the drain without a word of counsel or advice at the right time.

Table 2 shows the progress of these men. The status of the 1955 class is for two years, that of the 1956 for one year. It may be of interest to note the apparent power of the test for placement in Analytic Geometry. This is essentially a test of knowledge, not native ability. While a score of 35 is required for enrollment in Analytic Geometry, a score of 40 seems to indicate ability to stay in the engineering curricula.

Before hands are raised in horror at this poor record, it might pay to make a similar study of students in your institutions. You, too, may be shocked.

It would be fair to raise the question as to the causes of failure among these potentially gifted men. If we knew, we would be very pleased, and would not hesitate to tell you. Some apparent reasons would be:

1. Because of home and school background and social attitudes, college work is too challenging and demanding. The shock of adjustment is too great.

2. Other students of equal ability are bored by the slow pace of freshman teaching and lose interest. There

TABLE 2

STATUS OF STUDENTS AS OF SEPTEMBER 1957

Student	Present Curr.	G. P. A.	Anal. Geom. (1)	H. S. Rank (2)	Notes
1955 Freshman Group					
1	ME	4.493	36	96	
2	ME	3.475	32	66	Slow start—Finding self 3rd yr.
3	ME	4.324	53	51	
*4	ME	4.630	51	86	
5	ME	3.943	47	55	
6	IE	4.792	42	99	
*7	Gen. E.	3.194	—	88	
8	Eng. Phy.	4.690	43	98	1 year of M.E.
9	Fine Arts	3.356	—	—	3 Sem. of I.E.
10	Lib. Arts	4.571	43	99	1 Sem. of M.E.
*11	Dropped	2.389	—	84	Dropped end 2nd Sem.
12	Dropped	2.800	36	85	Dropped end 3rd Sem.
13	Dropped	2.552	31	60	2nd Sem. 9 hr. D
14	Withdrew	2.588	39	82	Prob. 1st Sem. Did not return
15	Dropped	3.109	—	89	4th Sem. 10 hr. E, 9 hr. D
*16	Withdrew	3.176	—	34	Trans. LAS after 1st Sem.
1956 Freshman Group					
1	ME	4.694	—	97	
2	ME	4.543	—	98	
3	ME	3.500	42	87	
4	ME	3.865	43	98	
5	ME	4.486	48	85	
6	ME	4.389	45	96	
7	IE	3.088	—	58	
8	Fine Arts	3.353	—	88	
9	Fine Arts	3.576	44	—	
10	Lib. Arts	2.833	33	28	D's in Math and Chem (2nd Sem.)
11	Comm.	2.667	—	88	Trans. end 1st Sem.
*12	Dropped	2.703	27	76	Trans. C.E. 1st Sem.; Dr. 2nd
13	Withdrawn	3.286	35	91	Failed Phy. 106
*14	Withdrawn	2.829	36	83	One Sem. only
*15	Withdrawn	W	26	77	Did not complete 1st Sem.
16	Withdrawn	373	15	92	One Sem. only

(1) Anal. Geom. Placement Test (Passing Score 35)
* Never contacted this program or Student Counselling Service
(2) HS Rank—Percentile

is literally too little that is new to them.

3. Bright students seem more sensitive to varying abilities of instructors than are their slower brethren. Unjustifiably perhaps, but frequently, these bright youngsters are frustrated by fumbling instructors. They are unable to move in and take responsibility for themselves. Actually, the system is against them.

4. There are bright students who are oversocialized, with associated problems of adjustment.

5. There are also bright students who are undersocialized, and these men have adjustment problems of a different and painful nature. In particular, bright boys from small communities may have had little opportunity to associate with others of a like mind, and thus have withdrawn from normal social relationships.

6. There are men of all ability levels who suffer a wide range of personality disorders. Some may be outright psychotics for whom we can do little as individual instructors. Family problems, girl problems, finances are very real barriers to academic fulfillment.

7. A sizable number of men of all abilities come into engineering with unworkable motives. We are all familiar with the frustrations of the hot-rod enthusiast, the ham radio fiend, etc. who find little in freshman engineering to satisfy their immediate need for manual self-expression. Parents, friends, and teachers frequently have undue influence in the choice of a career. Perhaps the most pathetic group of all are those men motivated by delusions of financial glory in engineering. The stronger this leaning toward tangible evidence of success, the less, it appears, can these men discipline themselves to study.

8. There are also men of unquestioned ability who suffer in engineering because of unrealized and unrecognized drives in such fields as art, social service and creative writing. While it is true that these interests can legitimately be coupled with engineering, they may be too strong for a given individual.

9. A catalog of problems would not be complete without the category of the "spoiled or lazy" students even though these might be included more properly in the other classifications.

One would be a fool who thought that he or anyone else could save all these persons. As a matter of fact, many of them do save themselves, which is the only way that they can ultimately be saved. We are personally convinced that a sizable number can be saved by careful counselling and guidance, and are also convinced that saving one in three, one in five or even one in ten is well worth the battle.

Problems

The major problems in the program are those of administrative mechanics. The first is that of getting the men into the initial group meeting and personal interview. A second problem is that of the conflict between the published list of registration advisors and the personally selected advisors. Communication between students, advisors and the departmental office is at the best a tough job. Both of these could be corrected by more diligent follow-up by the director of the program, or preferably by delegation to competent secretarial help.

Another problem is that of non-continuity of advisors. The senior faculty on the program do take leaves, and unfortunately (for the program) some find greener pastures elsewhere. Shifting personnel does weaken the structure to some extent. An always present problem is that of time for the participants to get together more frequently for discussions.

The Future

Despite the limited evidence of success, the department will continue its efforts in this direction. We are aware of the deficiencies of the program, and are hopeful that a public exposure of our plans and hopes will bring in ideas from the outside that will assist us. At the outset, we figured that it would be about six years

before any definitive results could be established. Win, lose, or draw, we expect to report again at that time. And finally, it is hoped that out of this will come an improved counselling procedure for all students.

SATURDAY CLASSES IN ENGINEERING COLLEGES

M. LAWRENCE PRICE

Dean of Faculty, Worcester Polytechnic Institute
Worcester, Massachusetts

Last spring, a questionnaire was sent to 110 Deans of Engineering Colleges requesting information on Saturday classes. The response to this questionnaire was phenomenal, indicating that others are interested also. Not one institution failed to reply.

The results are briefly tabulated as follows:

88% of the colleges hold classes on Saturday, of which
- 69% schedule classes for all groups of students as the need may require
- 1% limit classes to Freshmen only
- 4% limit classes to Freshmen and Sophomores
- 14% limit classes to laboratory exercises or special classes only

88%

Only 12% do not hold classes on Saturday, and 3% of this group indicated that it probably would not be very long before it would be necessary to schedule classes on Saturday.

Many special comments were included and some of them fitted the following patterns:

1. Tried to eliminate them but lack of space has forced us to go back to the old scheme.
2. Wouldn't have them if we had enough space.
3. Students and faculty don't like them but resistance is decreasing.
4. A large group indicated that the block system (M, W, F—Tu, Thur, Sat) required scheduling of Saturday classes.
5. A few indicated that they scheduled Saturday classes (and some scheduled examinations) for the purpose of discouraging long week-ends.
6. Many colleges are scheduling classes through the noon hour on a staggered basis.
7. A few colleges are not only scheduling Saturday classes but are extending them into the late afternoon. Three colleges contemplate early evening classes at the undergraduate level.

The general consensus seemed to be that students and faculty alike would rather not have classes on Saturday. However, there also seemed to be rather general agreement that we can't very well operate on a five-day week and accomplish the requirements of a weekly 50–54-hour student work load or overcome the difficulty of space limitations.

I greatly appreciate the prompt and tremendous response and hope that this resumé may be of some benefit to all concerned.

THINKING AHEAD IN ENGINEERING EDUCATION

The Place of the Engineering Technician

G. ROSS HENNINGER

Director, National Survey of Technical Institute Education; President, Ohio Mechanics Institute

A second progress report, presented at the Annual Meeting in Berkeley, June 16, 1958.

Today we have a problem. Now, problems are not novel in our daily life, and this particular problem is not new. It just sort of grew up suddenly on our blind side, and now, we are surprised—even startled to the point where our national wits tend to scatter a bit. Our problem is: How best to provide the technically competent manpower which we need now and which we seem destined to need so acutely in the foreseeable future. The answer to this problem involves both a better educational pattern and a better manpower utilization pattern and philosophy. The answer not only directly affects the personal lives and welfare of all the people involved, but seems to be a critical factor in our national security and in our whole social and economic structure. So it is indeed a problem of some moment, of direct significance and importance to our engineering profession and hence to engineering educators.

Our national problem arises from a much-publicized shortage of scientists and engineers. Regardless of debates involving the semantics or statistics of this situation, there is no dodging the fact that we do have shortages of adequate competencies in the right places. And this is a time of peace—or at least nothing worse than a "cold war" of nerves and technologies. We are just getting accustomed to universal travel by air with piston engines and turbines—with jets coming up—when we are confronted with the fantastic fact of spaceships actually in flight! Less dramatic by comparison now, we have electronic ovens for our kitchens and electronic "brains" just beginning to be translated on a major scale from military purposes into business and industrial uses. Things such as these require human brains and adroitness in tremendous quantity and of high quality.

And so we find ourselves on the threshold of our technological era, and already "fresh out" of qualified manpower. In spite of our "exploding population," not enough persons are being born daily to go through our traditional educational cycle and give us the quantity of engineers and scientists which we will need on the basis of our traditional methods of education and utilization.

The history of engineering is well known. We recall that the first engineering was for military purposes, followed by roads, bridges and aqueducts for the common people, and hence called "civil" engineering to distinguish it from the military. Then came mechanical, electrical, and the whole family of applied arts and sciences as the store of technical knowledge grew. All this we know, but how often do we ponder it in the light of its sociological import *today*?

In those early days these men did

not object to being called "electricians" or "mechanics." Even Charles Steinmetz, the "wizard" of early electrical science and education, was mentioned in contemporary literature as an "electrician." In fact, what about our present engineering colleges? The land-grant college system, which includes such renowned engineering schools as MIT and others, was set up as "colleges of agriculture and *mechanic arts*"—no mention of "engineering." However, as the fields expanded, there came a change. Professional consciousness took form, and the professional-technical societies were founded—partly for self-education, and partly for mutual prestige and promotion. Even in engineering education, you may recall that before the turn of the century the Society for the Promotion of Engineering Education was formed. Note the word "promotion." Even less than seventy years ago, engineering education itself was fighting for recognition and acknowledgment of respectability in traditional higher education.

Even now engineering education has its hassle with the traditional "Liberal Arts." Experiments and debates continue as to how much time can be taken out of a four-year engineering curriculum for social-humanistic studies, economics, business administration, history and government, and other topics intrinsically valuable, and still at the end of four years have an individual with enough of the available welter of scientific and technical information to be legitimately called an "engineer." And that reminds us of another question which is not too well settled: Just what is an "engineer"? Thirty to fifty years ago the scope of available technological and scientific information was of such proportions that the traditional four-year engineering curricula had a fair chance to cover the ground reasonably well. With continuing expansion of technical knowledge and growing realization of the scope still to be learned or digested for later application, the engineering spectrum—educationally as well as professionally—must be re-evaluated and re-divided—for example as indicated in the recent ASEE Grinter Report.

I mentioned Steinmetz. He was referred to as an "electrician" even though he was an outstanding authority on electrical and related science. In a way he was typical of the old "seat-of-the-pants" school, like Kettering, Edison, Ford, the Wright Brothers, and many others, learning things by doing them; and then similarly teaching others. In those days such people were, initially at least, one-man "teams" insofar as engineering explorations were concerned. Even as they developed beyond the initial stages, the individual could do the handwork as well as the brain work required, with the aid of supporting craftsmen, Mr. Bell and Mr. Watson of telephone fame, for example. Thus, with minor over-simplification, we can say evolved the "two-man team" of engineer-plus-craftsman to accomplish an engineering project.

Manpower Relationships—The Engineering Team

Times change, however, and we are beginning to see that in our national habit of Topsy-like growth, we have been trying to make-do with a 2-part "team" (the engineer plus the craftsman) beyond the ability of such a "team" to cope with the ever expanding technology of our daily life.

In the "2-man team" pattern, the engineer or scientist must take time to do for himself many parts of his work which do not require or justify his time or talents. In many instances such work would be done even better by a competent aid such as is envisioned in the Engineering Technician.

The time and effort of the engineer or scientist thus "salvaged" would directly enhance his productive capacity and hence his earning power and personal satisfaction.

So, at long last, we are beginning to give serious national recognition to the need for a 3-man "team" (the engineer, *plus* the technician, *plus* the craftsman) in the effective execution of an engineering project. This could be a major part of a lasting answer to our national question of adequate technical and scientific manpower.

To produce efficiently a 3-part "team" of satisfying effectiveness requires a 3-part educational program: (1) the university-collegiate program for engineers and scientists; (2) the technical-institute type of engineering program for engineering technicians, with counterpart programs in other technologies such as medical and dental, accounting, industrial production, secretarial science, and others; and (3) vocational-trade programs for the craftsman.

This "team" idea, of course, is not new. It was "discovered" and brought to public attention here in the United States about 30 years ago through national studies of engineering education and of technical institute education conducted by the American Society for Engineering Education. Perhaps I should say "rediscovered," because both the idea and this pattern of manpower co-ordination and utilization long had been the established pattern of the technically proficient nations of Europe. In fact, Europe was the seed-bed from which the idea was brought to the United States before the turn of the century. The idea "took," but in a scattered and desultory manner, perhaps because the engineering profession itself was then struggling for recognition in the same general area of technological activity, sometimes called "applied science."

Definitions

My approach to my topic is based upon two definitions. One describes a person in terms of a job-description. This person represents a segment of the engineering-industrial-scientific manpower spectrum. He (or she) represents also a comparable segment of manpower spectrum in other professional and business fields where in many instances he has been accorded recognition far beyond the over-cautious and preliminary beginnings to be found presently in the engineering-industrial field. This person is the Engineering Technician, and we define him thus:

The Engineering Technician

In general, the engineering technician is a person whose chief interests and activities lie in the direction of the testing and development, the application, and the operation of engineering and scientific equipment and processes. Classified on the basis of educational certification, the engineering technician would be a graduate of a technical-institute type of curriculum as accredited by Engineers' Council for Professional Development, or recognized equivalent. Classified occupationally, the engineering technician performs semi-professional functions of an engineering or scientific nature, largely upon his own initiative and under only general supervision of a professional engineer or scientist; he assists, and supplements the work of, the engineer or scientist.

Typical among the wide array of semi-professional functions performed by engineering and scientific technicians are: Drafting, design, and development of products and of engineering plant; installing and operating equipment, estimating costs, selling, and advising customers on the use of engineering or scientific equipment.

In many instances, the technician may serve as a liaison between the engineer or scientist on the one hand, and the skilled craftsman or layman on the other hand. In carrying out these various ac-

tivities, he may have group leadership responsibilities. The technician must be able to communicate mathematically, scientifically, and linguistically.

Technical Institute Education

Now we turn to a parallel definition. This one covers the formalized educational process designed to serve the person fitted to become an engineering technician. We define such a program as "technical-institute education."

The term refers to the intermediate strata of technical curricula which in general are of two years' duration (full-time) beyond the high-school level. Curricula are technological in nature, and they differ in both content and purpose from those of the vocational school on the one hand, and from those of the engineering college on the other hand.

Such curricula emphasize the understanding and practical application of basic principles of mathematics and science as they relate to a major technical specialty, *rather than* the acquisition of proficiency in manual skills. High school graduation is required for admission, and mathematics through algebra and geometry are prerequisite.

The programs of instruction are similar in nature to, but briefer and more completely technical in content than, professional engineering curricula. The major purpose is to prepare individuals for various technical positions or specialized areas of activity encompassed within the broad field of engineering enterprise.

The objective of these definitions is to contribute to a better understanding of the significant common interests and differences in the somewhat troubled boundary area between the engineering technician and the skilled craftsman on the one hand, and between the engineering technician and the engineer on the other. These areas of relationship are of the utmost importance to the engineering profession in general, and they hold particular significance and potential for the American Society for Engineering Education. They present to us in engineering education a challenge and an opportunity for leadership if we can but see it soon enough, and *do* something about it.

Relationships in Educational Spectrum

In considering the proper place of the technical-institute program in our national educational and professional spectrum, attention must be focused upon the fact that it is the engineering field which has "exploded." As engineering moves into the realms of science in contradistinction to the realms of application and operation in which it started and has grown, two facts stand out with increasing clarity.

One of these is that some adequate and integrated provision must be made to continue to supply the technically competent manpower required for this ever-expanding area of engineering application and operation, and required also to augment and to supplement the professional engineer and the scientists in research, design, development, and supervision. In any event, this manpower is a part of the over-all engineering manpower spectrum. In general effect, this technological manpower is taking the place of "the engineer" as we have known him, as "the engineer" becomes more and more devoted to the scientific problems and opportunities of the expanding technological universe. This manpower area is the professional area of the Engineering Technician. Neither engineering education nor the engineering profession can afford to ignore this.

The second fact is that, for his optimum development, the Engineering Technician is best served by an educational program which is intimately related to, but which differs significantly from, the program most effective for the engineer. In contrast

with the engineer, the Engineering Technician does *not* need to have either the depth or the extent of mathematical or scientific understanding required by the engineer. However, he does need a practical working understanding of essentially the same subject matter, together with appropriate communications skills. This requires an educational approach comparable in quality and general level to the university-collegiate engineering program, but differing significantly in that the emphasis is that of practical application of established scientific principles rather than the development or extension of new scientific knowledge.

Similarly, in contrast with the craftsman and his highly commendable educational program of vocational-trade-skills and "know-how," the Engineering Technician does *not* benefit significantly from the development of proficiency in manual or related skills nor from technological subject matter taught from that angle. However, the Engineering Technician *does* need to have—or at least can profit by having—a general working knowledge of the nature of manual skills related to his area of interest. This requires an educational approach distinctly different from and of much more rigorously technical level than the program effective for the craftsman and commonly represented in the vocational-trade or "vocational-technical" program with which we are all familiar. This significant and necessary distinction is broadly overlooked in the efforts currently being made to obtain a Federal subsidy program of program-extension for so-called "Area-Vocational" schools.

The nation-wide consensus among the Regional Committees of the Survey is overwhelmingly to the effect that the technical-institute type of educational program lies much closer to the professional levels of engineering than to the "vocational" program. Here, it should be clearly understood that this in no wise is a reflection upon the "vocational" program, but merely a statement of proper relationship. There is strong evidence that these critical distinctions are confused in the proposals currently being promoted by vocational interests in several states.

This brings up another question: What is the relationship between acceptable technical-institute type curricula and the typical basic "pre-professional" curricula of the junior college or "lower-division" collegiate curricula leading to the engineering degree? At the risk of over-simplification, I may say that the person who finishes the first two years of an engineering curriculum as presently cataloged by most of the ECPD-accredited engineering colleges and universities is *not* adequately prepared for productive employment, either as an engineering technician or as an engineer. Such a person has too much of too little to qualify as an engineering technician, because he is only at the threshold of his engineering professional-technical subject matter.

This leads to another point of major importance: The misguided idea that the zone of the Engineering Technician is the natural "dumping ground" for those who "can't make the grade" in engineering. As a matter of fact, most of those unfortunate misfits who cannot make the grade in engineering as now handled educationally or professionally would be just as miserable misfits in the field of the Engineering Technician. Part of this confused thinking is just carelessness; part of it is ignorance, whether willful or accidental; and part of it—let us face it—is selfish fear of loss or compromise of social or professional "position" by our friends in border-line zones of

educational or professional enterprise. Regardless of source, all such confusion is damaging to everybody concerned.

The field of the Engineering Technician is no more logically to be considered the "dumping ground" for misfit engineers than is the field of engineering logically to be considered as the "dumping ground" for misfit scientists. These inseparably interrelated fields are co-equal in their importance to our whole social and economic—and professional—structure. They deserve to be accorded interrelated status and recognition accordingly.

Need for Technicians

In discussing the Engineering Technician, we need to be reminded that in many other professional and technical fields the technician and the "technical institute idea" in higher education have received far more recognition than in engineering. Among these are the long-established medical technician, the newer dental technician, technicians in business operations, the fields of accounting, secretarial science, personnel supervision, and others.

There are two aspects of this question of "need" which are of significance to us in the engineering profession. There is the growing numerical need, to serve the collective and mutual interests of our social and economic structure. This means more people adequately and appropriately educated in the fundamentals of science, and trained and inspired in technological thinking. Also, there is the socio-psychological need and opportunity to develop more people to capacities more appropriate to their individual aptitudes and interests. This is of importance to both the individual and the community.

Educational institutions have not provided the technical manpower that industry needs. This has forced industry to establish internal educational programs to satisfy these needs. There are two general types of such programs: (1) Those traditional in American industry since the beginnings of engineering; and (2) those carried over from World War II when they were developed to provide untrained personnel a rather complete—if short and intense—training in the specific partial technologies peculiar to particular industrial operations. The traditional programs brought engineering graduates into protracted "training periods" of routine shop or drafting-room work, much of which is well below the level expected of today's engineering technician. In practice, such programs provide technical manpower on a cheap basis. In effect they constitute a psychological, as well as physical, waste of manpower and talent. The more alert industrial concerns have quit this wasteful practice, and make appropriate use of engineering technicians for the technical work and trained mechanics for the manual work. Their engineering-graduate trainees are placed in engineering work for engineering experience and training. But much of American industry has not yet learned about the Engineering Technician and hence does not yet realize either his technical or his sociological potential in the technological manpower spectrum. This is at once a responsibility and opportunity for Engineering Education.

We have been caught in the wave of rapidly expanding and changing science and technology. With too-few exceptions, we have been allowing ourselves to be swept along both educationally and professionally with our minds pre-set upon, and preoccupied with, a technological manpower structure no longer adequate. Our traditional concept of engineer-

ing is no longer appropriate, either educationally or professionally. If Engineering Education is to exert or deserve the leadership to which it properly aspires, our concepts of the technological manpower spectrum must be geared to the-day-after-tomorrow, rather than to the-day-before-yesterday. In this rapidly moving world, we cannot afford to harbor the thoughtless misconception that the engineering technician is anything other than an inseparable part of our professional engineering family. And beware also of thinking of him as a "lowly part," for tomorrow much of our work of today in the exacting realm of engineering science will have been developed to an application technolgy which can be performed more effectively by a properly qualified Engineering Technician.

Much is being said about the seemingly over-large proportion of our high school graduates who do not go on into higher education. Among the reasons which should concern us in engineering education has been the fact that many of these persons having technological interests and aptitudes do not want four years of college. They want applied science or what we are coming to call the "technologies." Consequently, the need for a general recognition of the "Technical Institute Idea" in higher education is clearly indicated as a logical channel for the expansion of our total technological manpower. Some of our leading engineering colleges and universities already sense this. Similarly, recognition by the engineering profession of this intermediate area of the over-all professional pattern of engineering and scientific manpower would be a logical companion step.

Better Manpower Balance

In our present national economy we have a confirmed need for qualified technicians in engineering and related technologies which numerically exceeds by several times the much-talked-about need for scientists and engineers.

In fact, one of the most productive ways to increase our effective supply of engineering-scientific professional manpower is through the integrated development and utilization of persons qualified to be Engineering Technicians. We must have the courage to turn over to the Engineering Technician all segments of yesterday's engineering and science which have become today's technologies. And we must recognize that these are very large segments. By doing this methodically and determinedly, we would correspondingly release the time and energies of our qualified engineering-scientific manpower. This would conserve manpower because only two years are required to develop an Engineering Technician in contrast with the requirement of four or more years to develop the engineer or scientist. Further, we thus take into account that intangible but very important factor of the personal and community value of having a person in a job which is in keeping with his interests and aptitudes.

Such evolution naturally involves problems. But we must remember that the problems are not created by this evolution, merely revealed. Many problems are the outgrowth of fears, and these can be ventilated and dissipated by rational thinking. For example, the fear has been expressed in engineering education circles that recognition of the Engineering Technician and participation in the technical institute zone of education would pollute and stultify the collegiate institution and its programs. This groundless fear has been dissipated markedly within the past year, on the basis of the fruitful experiences of leaders

among the institutions of higher learning. We now find a definite trend of increasing participation in technical institute curricula designed to produce Engineering Technicians. Again, the fear has been expressed in professional engineering circles that "if we go along with this 'engineering team' idea, and accept Engineering Technicians as assistants to carry some of the load that we have been carrying, we should guard against their learning too much about our jobs lest they get our jobs away from us." This is an understandable reaction, but not a very searching one. If such a fear represents any real hazard with reference to any particular job, the answer probably lies in the fact that the job is not one requiring an engineer as now conceived, and thought should be given to that aspect.

To help to get our thoughts properly focused upon our apparent problem area, let's make another approach from a different angle. How far would we go today in recommending a baccalaureate degree for a recently graduated candidate fresh from an engineering curriculum of 1890, or 1900, or 1920 when, for example, foundry technique was an important item in the Mechanical Engineering curriculum, and the actual winding of an electric motor was an important item in the Electrical Engineering curriculum? Intrinsically, these and other such items are just as important today as they were then, but their relative position in the expanding area of engineering and science is significantly different. Times have changed and are still changing; frontiers have moved, and are still moving. Our manpower concepts, both social and educational, must keep pace.

If we of the engineering profession can but remember the history of our own brief existence, we should be able to recognize the plight of the Engineering Technician today in needing professional recognition. Just a few decades ago, our engineering profession was in exactly the same relative position when it was striving for its "place in the sun"—for recognition and acknowledgment of respectability in a long-established hierarchy and cloistered tradition of higher education.

Which Schools?

Let's consider briefly the question of which schools are, or should be, concerned with this technological education.

First, we must acknowledge the fact that American industry as a whole has developed tremendous internal training and educational programs, ranging from trade apprenticeship training to the highest levels of collegiate graduate work. In subject matter, they range from manual skill training to industrial management and from English and speech to nuclear theory. The universal objective is to develop available manpower to meet the needs and philosophies of the individual enterprise. In our National Survey of Technical Institute Education, we specifically refrained from any attempt to assay this huge phase of America's over-all pattern of education. This would be a job in itself. However, we must not overlook it, especially when making international comparisons.

The senior colleges and universities of the United States, with few exceptions, have preoccupied themselves with baccalaureate and advanced-degree programs to the exclusion of technological curricula designed to develop technicians in engineering and other subject fields. However, an increasing number of colleges and universities are recognizing the significance and potential of this intermediate zone of higher education by

offering technical-institute curricula, or by being actively engaged in their development.

The junior or community college—some 650 strong in the United States—is, with but minor exceptions, just at the threshold of any significant participation. In potential, however, it cannot be ignored, especially in the light of rapidly increasing requirements for educational capacity. Basically, it is a multi-purpose institution. Statistically, it is overwhelmingly concerned with "general education" objectives as represented by "liberal-arts" and "college-transfer" programs. All too many of those showing interest in technical subject matter confuse the significant distinction between effective technical-institute curricula on the one hand, and vocational-trade curricula and "shop" courses on the other hand. In any event, what the junior college in the U. S. can do, or should try to do in the area of technological curricula for engineering and other technicians, depends entirely upon the circumstances—the leadership, and the philosophy controlling each individual institution.

From the facts thus briefly summarized and necessarily over-simplified, we discover that it is the independent technical school which has "carried the ball" of intermediate technological education and given continuity to the "technical-institute idea" of organized occupational curricula in the United States. We should not be surprised at this, for traditionally it has been the independent educational institution which has pioneered new concepts, new areas, and new methods of education. The independent institution occupies a position of especial opportunity and responsibility because of the inherent privilege of relative freedom and flexibility in policy and procedure which it enjoys.

Preliminary and incomplete returns from our recent National Survey reveal that some 120 educational institutions are offering technical institute curricula. Thirty-five of these appear on the current ECPD roster, offering a total of 109 accredited curricula in 11 different areas of engineering technology.* This group covers 16 states** and, through the medium of dispersed "centers," is actually operating in 51 different locations.

In addition, we find some 50 junior or "community" colleges and 35 other public, private, or industrial schools offering curricula of approximately equivalent nature. Beyond this, we find a miscellany of schools including many junior colleges offering a variety of vocational-trade courses of such a nature as to develop mechanics rather than engineering technicians. Some of these schools erroneously call themselves technical institutes.

Among our gross of 120 schools, we find some 75 public tax-supported in-

* 1. Air Conditioning, Heating, Refrigeration
2. Aeronautical
3. Building Construction
4. Chemical
5. Civil
6. Diesel or Automotive
7. Drafting and Design
8. Electrical
9. Electronic
10. Industrial or Production
11. Mechanical

** 1. California 4
2. Connecticut 2
3. Dist. of Columbia 1
4. Georgia 1
5. Indiana 3
6. Illinois 2
7. Kansas 1
8. Massachusetts 2
9. New York 6
10. Ohio 4
11. Oklahoma 1
12. Oregon 1
13. Pennsylvania 4
14. West Virginia 1
15. Wisconsin 1
16. Texas 1

stitutions and some 45 independent institutions. Several universities and engineering colleges are operating very effective technical institute programs. As of 1956, this group of 120 schools showed a total enrollment of 48,000, with 11,000 Engineering Technician graduates annually. This is only about 10 per cent of the presently indicated potential need.

I mention the "potential" aspects here for two reasons: First, because naturally where qualified technician graduates are not available make-shift measures are serving as fill-in, and hence to the casual observer the situation may seem to be in balance; second, because, in spite of pioneering examples of outstanding significance, both industry and the engineering profession in general are only beginning to understand or acknowledge the inevitable place of the graduate technician in the manpower spectrum. Beyond the meager supply currently being graduated by recognized technical institutes, today's needs for Engineering Technicians are being met partly by misapplication of graduate engineers, and partly by mechanics and others upgraded carelessly to capitalize upon the allure of the title "engineer" and the looseness of cost-plus contracts.

Conclusion

In any event, it is becoming very clear that, for the good of our national economy in the light of our total manpower potential, we are rapidly approaching the time when our technological manpower team will be composed of something like 10 engineering technicians and 150 skilled mechanics for each engineer or scientist.

As to the facts of life which confront us, we may close our eyes to them, but they still will exist. These may be summarized and epitomized by paraphrasing an earlier statement: In spite of our rapidly growing population in the United States, the manpower requirements of our "exploding" scientific and engineering frontiers are such that not enough persons are being born to go through our traditional educational cycle and give us anywhere near the quantity of technological graduates which we need under our traditional and outmoded methods of education and utilization.

Something needs to be done—and done on a long-range basis. We do not need a "crash" program unless it be a crash to awaken us and jar us into courageous and intelligent action. Are we in ASEE going to sit back and let someone else do this, in our own engineering-scientific field? Responsibility for this is implicit in our assumption of responsibility for engineering education. The opportunity is here—now.

And this reminds me of a pertinent observation which I had the privilege of hearing personally from Charles F. Kettering. He said: "The main reason for the unpleasant surprises which we discover each day lies in the fact that we spend so much time walking backward watching with pride where we have come from!"

AN EXPERIMENT IN THE REDUCTION OF PHYSICS CONTENT

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Presented to the Electrical Engineering Division Conference at the 66th Annual Meeting, June 18, 1958. Recommended for publication by that Division.

The *Report on Evaluation of Engineering Education* includes the statement, "*Modern physics, including an introduction to nuclear or solid state physics, should be a part of undergraduate engineering curricula.*" In the same paragraph it is also stated that "*An introductory course in physics that attempts to be a tool subject for engineering mechanics, thermodynamics, and electricity appears to serve less and less purpose.*" The juxtaposition of these two statements in the *Report* certainly points up a basic need of engineering education and also seems to indicate a possible solution. Whenever we are requested or feel it necessary to add additional material, we are always faced with the problem of available time or credit hours. The necessity for training of all engineers in at least the language and concepts of modern physics seems to be fully apparent since the events of the last year, and the credit hours available in the introductory physics course seem to provide a possible source of time for introduction of the modern physics concepts.

This writer has discussed the subject several times before, and feeling that sooner or later someone would remind him of Mark Twain's remark about the weather, he has been able to do something about the question through cooperation of the engineering staff at Michigan State University. This paper is a report of one simple and probably psychologically unprofessional experiment in the direction of measuring the need for the traditional introductory physics course.

Definitions

Before discussing the experiment it seems desirable to consider a question of semantics around which a lot of the difficulty between physicists and engineers seems to revolve. Somewhere there has appeared a definition for a physicist as "a person who works in areas in which physicists work." On the surface, this remark appears facetious, but a little thought indicates that it carries more than a little truth. It implies first, that a physicist's field of work goes with him, or, more properly, he carries the field along as he goes into new areas. If one defines as classical physics the areas of mechanics in macrodimensions, heat, electricity, light and sound, then by the above definition this was physics of an earlier day, because physicists did indeed work in these areas. However, most physicists today work with the mechanics of microdimensions, with the atom, and with the nucleus, and by the definition this is physics today. In addition, as engineering education turns more and more to the education of the engineer-scientist for the world of the future, it obviously must invade more and more of the area which was once classical physics, and this area must become engineering, because it is in fact the science of classical physics which we are ac-

tually now calling engineering science. When engineering was a field of application, then the fundamentals could remain physics, but as engineering becomes a field of science it must lay claim to its own fundamentals.

The writer has previously discussed questions of repetition of material, the adequacy of a survey course over the terrific amounts of physics material covered in an introductory course, and the comparative depth of treatment of the more popular physics books as against those books considered as doing a good introductory job in engineering, and these comments will not be repeated here. It should be said, however, that we have in the past given the physicist a very tough job. He has performed well under the boundary conditions we imposed, and all we are now asking is that he shift his efforts from a field in which he presumably has less interest to one in which he probably has more interest because this new field is as yet his own personal property. Let him be warned, however, that this field of modern physics will one day be engineering after the physicist has moved on to the physics of the stars, and I hope that he can already feel the hot breath of the pursuing engineers upon his neck. Out of such pursuit comes modern progress.

The Program at Michigan State

All engineering departments at Michigan State University have introduced at least one course in modern physics at the junior or senior level. To provide time for this and to permit greater scientific depth in some of their own areas, several departments have begun to move away from the traditional introductory physics course previously given in the sophomore year. Since Michigan State University is on the quarter system, the introductory physics course has been divided into one quarter of mechanics, one quarter of heat and electricity, and one quarter of modern physics. The Electrical Engineering Department, in common with the departments of many other universities on the quarter plan, has for some time not required the quarter of electricity and heat in the physics course, choosing instead to start its own students in the fundamentals of electricity at the same time as they would have been entering the course in physics. Several years ago the Mechanical Engineering Department moved to no longer require the quarter of mechanics and the quarter of heat and electricity. They retained the third quarter on modern physics, but moved it to the junior year where it is now contiguous with the course in advanced modern physics and will ultimately make possible an integrated two-term sequence.

For the past two years we have had sophomore mechanical engineers who have not had the course in mechanics in physics, and other sophomore engineers who have had this course, jointly entering our course in statics in the department of Applied Mechanics. This course in statics immediately follows the course of mechanics in physics. It has thus become possible to compare two year's classes in which some of the students had had the course in physics and some had not. In neither year were the statics instructors advised that they might expect this situation, and in neither year have there been any remarks by these instructors as to any lack of preparation indicated by their students. It should, of course, be stated that it has been customary for our statics course to begin at the beginning, assuming no prior knowledge of the subject of forces or other material. After completion of the course in statics the grades received by the students have been correlated in several ways in an

attempt to determine if the physics course in mechanics had aided those taking it or not.

Table I is a correlation of grades received by those students who had taken the mechanics course in physics with their subsequently received grade in statics. Essentially, this chart states that grade begets grade. In other words, the tendency is for a student receiving a C in physics to also obtain a C in statics. Essentially, the chart shows that for all but nine students out of the total 77 students represented, every student received within one letter grade, plus or minus, of the same grade he received in physics. In fact, the chart is really a good demonstration of the accuracy of our grading procedures, and does not seem to give any indication that because a student had physics he performed better in statics, and simply seems to indicate that once a C student, always a C student.

The second chart compares the records of all the students, with and without physics, against their point averages on the basis of A = 4.0. The numbers in the chart represent per cent of the total group being measured, the actual number N being 77 for the students having the physics course and N = 100 for those not having the physics course. In order to obtain a meaningful representation the students have been grouped in blocks of point average measuring 0.5 point; thus, one group of students is represented by those having point averages from 2 to 2.5, another from 2.5 to 3, and so on.

The taking of the mechanics course in physics, prior to completing the statics course, does not seem to have any influence on the grades received in statics beyond the general area of plus or minus one letter grade. It can be seen, for instance, that except for one student in each category, all students receiving A had point averages above 2.5. It can also be seen that 9.0 per cent of the students who had not had physics did fail statics, and 5.1 per cent of the students who had had physics failed statics. Counterbalancing this slight demerit against not taking physics are the facts that two students in the range of 1.0 to 1.5 passed statics with grades of B and C without having had the course in physics. It seems possible to find

TABLE I

RELATION BETWEEN PHYSICS (MECHANICS) AND STATICS (APPLIED MECHANICS) GRADES

		Grade in Statics				
		A	B	C	D	F
Grade	A	3	5	2		
in	B	6	5	2		1
Physics	C	5	12	17	5	
(Mechanics)	D	1		5	3	2
	F				1	2

TABLE II

STATICS (APPLIED MECHANICS) GRADE VERSUS POINT AVERAGE

Per Cent of Total Students

		Statics Grade									
		A		B		C		D		F	
Students'	4.0–3.5	4.0	1.3	3.0	1.3						
Accumulated	3.5–3.0	2.0	10.0	6.0	5.1	8.0	—	3.0	—		
Point—	3.0–2.5	5.0	6.4	9.0	10.0	26.0	10.0	3.0	1.3	1.0	—
Average	2.5–2.0	1.0	1.3	1.0	6.4	10.0	19.0	2.0	7.7	6.0	1.3
(A = 4.0)	2.0–1.5			1.0	—	3.0	7.7	1.0	6.4	2.0	3.8
in Range of—	1.5–1.0			1.0	—	1.0	—				

Underlined = Had physics (mechanics) (N = 78).

Not underlined = Did not have physics (N = 100).

such counterbalancing results to set off against any conclusion that one starts to draw from the results, thus leading to the general conclusion that having taken the course in physics dealing with the subject of mechanics has substantially no influence on the student's performance in statics in the quarter immediately following.

There may be some secondary effects which do not show in this simple experiment. One of these of which we are fully aware is the use of the CGS or MKS system in physics and the use of the English system of units in the statics course. This is a subject which we are now studying and which will probably lead to some treatment in the statics course with CGS or MKS units. In addition, all of our engineers take electrical engineering, and we can depend upon the Electrical Engineering Department to also introduce MKS units. We feel it is important to insure adequate scientific broadening of our students, but we do not feel this one point is anywhere near sufficient justification for taking the complete introductory survey in physics. Thus, at the present time we have concluded that this simple experiment confirms the step taken at Michigan State University in the elimination of some of the classical physics training as a pre-requisite to more advanced engineering work.

PLACEMENT SURVEY OF 1958 ENGINEERING GRADUATES

Of an estimated 33,000 graduates of 1958, 83.5 per cent were hired a month before graduation. Despite unfavorable economic conditions in the U. S., only 10 per cent had no definite plans by late May, and, as of June, none were without job offers.

A full report of the results of this survey is available from Engineers Joint Council, 29 W. 39th Street, New York 18, New York.

The Background of

ENGINEERING EDUCATION IN RUSSIA

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Adapted from an address delivered on the occasion of acceptance of the Timoshenko Medal, Dec. 3, 1957.

Since the last war the people in this country have become increasingly interested in engineering education on a world-wide basis. I would like, therefore, to discuss briefly the organization of engineering schools in Russia.

Russia has always had the reputation of a backward country, but this concept cannot be applied to its institutions of higher learning. At the beginning of the twentieth century, Russian universities and Russian engineering schools were on the same level with the best schools of western Europe. *We had academic freedom.* The schools were self-governed bodies and all power was in the hands of professors' councils. Members of these councils elected their administration, their president and deans, and all new professors.

The engineering schools in Russia were separate from universities and were usually organized for specific fields of engineering. Thus we had schools of mining, schools of electrical engineering, technological institutes, and so on. These schools had usually five-year programs, and *students were admitted only on the basis of a searching competitive examination.*

The engineering profession was considered in Russia as one of the highest and best. Thus, pupils of secondary schools would eagerly compete for entrance into one of the engineering schools. As a rule there were several candidates for each vacancy. The principal subjects in entrance examinations were: algebra, geometry, trigonometry, and Russian composition. Sometimes there were also examinations in physics, foreign languages, freehand drawing, and so on.

To prepare pupils for such examinations, the secondary schools had substantial programs in mathematics and the sciences. In my time (1888–1896), for example, we had five years of algebra, three years of geometry, one year of trigonometry, and three years of physics. We also had descriptive geometry, including perspective drawing. The requirements were very stringent and only a minority, some 20–25%, were graduated from these schools in the prescribed time.

The majority were unable to satisfy the requirements and left the school before graduation. Many left the secondary school at the age of about fourteen and entered the lower technical schools where they received training in engineering without the use of calculus. From these latter schools we obtained our draftsmen and engineer's helpers in field work.

The broad cultural training in the secondary schools, coupled with the high college entrance requirements, made it unnecessary to require additional training in humanities. The entering students were well educated in languages, literature, and history; thus the engineering school programs dealt only with exact sciences and with engineering subjects.

The Revolution

The 1917 Russian revolution ruined the established system of engineering education. The self-government of the schools was suppressed. A commissar with unlimited power was appointed for each school. He in turn appointed the administration and the professors and interfered with the methods of teaching. The rules for admission were also completely changed. Instead of selecting the students on the basis of abilities, "class distinction" was introduced as a consideration. The Russian class of intellectuals was opposing communism, while the communists were anxious to create an intellectual class which would be in sympathy with the communist regime.

In order to accomplish this, the entrance examination and the selection of students on the basis of their abilities were discontinued, and only children of workers and peasants were admitted to the engineering schools. However, these students had not, as a rule, a satisfactory preparation and could not follow the lectures given in the engineering schools. Thus it became necessary to organize special preparatory schools in which the training in elementary mathematics and other subjects required for the study of engineering was given. But these preparatory schools met with little success.

The workers taken from industry were usually too old to absorb mathematics. A great majority of them never completed the training in the preparatory schools, and were returned to industry. Only a minority could be admitted to the engineering school, but even then their preparation was poor. Thus lowering of the requirements became mandatory. Various new methods of teaching were tried, but were again unsuccessful. As a result, during the first ten years of the communist regime, the engineering educational system in Russia was completely ruined.

Rebuilding Industry

During the same period Russia began the rebuilding and further development of industry. The number of available engineers was insufficient; and the use of engineers from foreign countries proved to be unsatisfactory. It became necessary to reorganize the system of education and this was done very energetically.

A majority of the revolutionary-time reforms were suppressed. Strict discipline was again introduced in secondary schools. The programs of teaching, especially in the sciences and in mathematics, were brought to the level of the pre-revolutionary time, and so, in a few years, Russia had gained again a sufficient number of well-prepared candidates for higher education. The profession of engineering became still more respected than before, and the best pupils of secondary schools wanted now to become engineers.

The engineering schools removed class distinction limitations, and again introduced competitive examinations for selecting pupils with the best abilities. A majority of the revolutionary reforms in engineering schools were thus eliminated and in many respects the pre-revolutionary conditions returned. However, some important changes remained.

The schools never regained their academic freedom, and are now governed by directors affiliated with the communist party, and appointed by the central government. There is also a communistic student organization supervising the student's life. Severe discipline now reigns in the schools. It can easily be enforced, for the students receive government scholarships which can be taken away from them

if their work *or their behavior* is deemed unsatisfactory.

Presently, a majority of the schools are attached to some field of industry and exhibit a much narrower specialization than was the case before the revolution. They have five-year programs. The first two years are devoted principally to such fundamental sciences as mathematics, mechanics, physics, and chemistry. Inasmuch as the students enter the colleges with a very good mathematical training, advanced requirements in these subjects can be achieved.

Let us consider, for example, the field of mechanics. About twice as much time is allotted to this subject in a Russian college as is true in this country. Instruction in mechanics begins in the freshman year and during the two semesters statics and kinematics are studied. During the sophomore year the students study dynamics of a particle as well as dynamics of systems of bodies. Two semesters in the sophomore year are devoted to the study of the strength of materials. All of these courses have usually three hours of lectures and two hours of computational exercises. The strength of materials course has in addition two semester-hours of laboratory work.

The last three years of the curriculum are devoted to engineering subjects, and due to narrow specialization a substantial program can be completed in a given field. The basic idea underlying this type of training is to give to a young engineer such an education that after graduation he will immediately be able to begin working independently. In addition to class work, the student is required to gain some practical experience during summers. Since the schools are now connected with corresponding industries, summer work can be properly organized.

The number of engineering schools in Russia has increased considerably since the beginning of forced industrialization. This was accomplished principally by subdividing the old schools. As an example, consider the Polytechnic Institute in Kiev. Originally it had four subdivisions: Mechanical, Civil, Chemical, and Agricultural Engineering. The division of Agriculture was moved beyond the city limits. Thereupon Mechanical Engineering was subdivided, and the part dealing with Electrical Engineering formed a new, separate, Electrotechnical Institute.

Finally, the Civil Engineering Department was removed, and this led to the establishment of three new schools, namely: the Hydrotechnical Institute, the Institute of Transportation, and the School of City Planning Engineers. Thus, instead of a polytechnic institute with four divisions, there exist a Polytechnic Institute with two divisions and five additional engineering schools. At times some entirely new engineering schools were organized, especially in the regions with new industrial development. But until now the best engineering schools are the old ones, the same that existed in pre-revolutionary times.

With the increase in the number of schools of engineering and the number of students, the question of preparation of additional teaching staff became very important. To solve it, several new positions for so-called "aspirants" were attached to each professorship. An aspirant is given a government scholarship and must carry on his scientific work under the guidance of the professor for the period of three years, then pass a final examination and prepare a thesis. If his work is satisfactory, he earns the candidate's degree which gives him the right to an instructorship. Because the teaching positions at engineering schools are esteemed very

highly, the best students would compete for aspirants' vacancies.

In order to occupy a professorial chair, the candidate must have earned a doctorate, which requires a doctoral thesis as well as its formal defense in an open examination. The position of a professor is esteemed very highly in Russia. A professor receives a high salary, some eight to ten times larger than the salary of a workman, so that professorships in the engineering schools attract the best talent of the country. The number of professors is not large; approximately fifteen per cent of the teaching staff is in this category.

Thus, a school having some 2,000 students will as a rule have a teaching staff of about 200, and among these there would be about thirty professors. The seniority principle is not used in Russian engineering schools. There are no promotions from an instructor to a professor. All professor's vacancies are filled on the basis of competition, and experience shows that this represents a very healthy practice.

The Russian engineering schools are considered to be not only teaching institutions, but also centers of research in engineering sciences. One can deduce from the quantity and quality of Russian technical publications that a considerable volume of scientific work is going on in engineering sciences, and that a substantial portion of it is contributed by the teaching staff of the engineering schools.

Thus the Russian schools have returned today to their high pre-revolutionary level. They enroll students with good mathematical preparation. They have competent teaching staffs and well-trained productive research scientists.

SURVEYING TEACHERS CONFERENCE PROCEEDINGS AVAILABLE

The Proceedings of the Fourth National Surveying Teachers Conference were published last summer and are available for distribution. The Conference was held in August, 1957, at Washington State College's Summer Survey Camp at Naches, Washington. It was sponsored by the ASEE Civil Engineering Division's Committee VIII, Surveying and Mapping, and the Civil Engineering Department of the State College of Washington.

The Proceedings include papers on recent developments in surveying, and techniques and problems of teaching surveying. There are discussions of the development of surveying curricula and a report on surveying instruction in Switzerland. An even more international flavor is added by a paper on the geodesic studies of the International Geophysical Year.

Copies of the Proceedings are available from D. H. Harkness, Secretary, Committee VIII, c/o W. & L. E. Gurley, 514 Fulton St., Troy, New York, at two dollars per copy, postage paid.

COOPERATIVE TEACHING OF TECHNICAL WRITING IN ENGINEERING COURSES

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Recommended by the English Division

Undoubtedly, every teacher of engineering has the problem of introducing realism into his courses. But the teacher of technical writing faces a special challenge. He cannot fill his classroom with impressive hardware and machinery, nor can he perform dramatic experiments with physical objects. Instead, he must try to create a realistic writer-reader situation, with only words at his disposal.

If he relies solely on the familiar English course in technical writing as his means of communication, his chance of creating realism is remote. Most engineering students resign themselves at an early age to a sort of "peaceful co-existence" with such courses "from the other side of the campus," and not infrequently with the English language itself. Some aren't convinced of the importance of developing their writing skills until they are face to face with their first on-the-job report assignment. Furthermore, the instructor cannot hope to build a make-believe industrial scene that will provide the many personal pressures of the real thing.

What, then, are the possible solutions? Clearly, courses given jointly with industry, in which the student spends part of his time "on location" at a plant or business, are ideal for introducing instruction in report writing. Not only does the writer have a real subject to write about, but he also has a live audience. I suggest you investigate this area thoroughly; it offers an excellent base on which to start a technical writing program.

Unfortunately, integrated field and classroom courses are scarce, and at present would account for only a small segment of our engineering and science undergraduates. So we must look for a broader, more practicable scheme. One sure-fire technique is to combine the study of engineering and writing at strategic points in the conventional curriculum so that the student will accept the added responsibility as part of his professional training.

The idea is not new; on the other hand, the method of instruction has undergone some radical changes and should raise interesting points for discussion. As a basis, suppose I describe as briefly as I can the cooperative plan now offered by the Humanities Department at M.I.T.

The M.I.T. Cooperative Plan

The M.I.T. cooperative teaching plan consists of dovetailing technical reports with the components of a regular engineering subject, usually a laboratory course. Writing is taught as an integral part of this course, rather than as a separate English subject. The responsibilities of planning, teaching, correcting and grading reports, and holding editorial confer-

ences, are shared jointly by engineering instructors and the instructor in technical writing from the Department of Humanities. From about one-fourth to one-sixth of the course time is needed for this special instruction. The heavy consumers are the Electrical Engineering and Mechanical Engineering Departments, but several others have participated at one time or another. There is nothing compulsory about adopting the plan; Humanities supplies the service upon request.

Specific Example

To give you a better idea of how the plan operates, I will run through a typical case. At the beginning of the year, I meet with the staff of an engineering course—say, the senior mechanical engineering laboratory. They brief me on the technical content of their subject, especially on the number and nature of the experiments, and the time each will take. We then look for the best spots to include special written assignments, and discuss the types of reports that will best fit the subjects and the time allotted. The standard number is four: three short reports and a term project report. Details of the assignments are worked out at a later session.

Also at this first meeting we schedule my lectures. These are always held in the engineering classroom at regular class hours. I purposely keep the number low, generally to three, preferring to concentrate on informal instruction in individual conferences. The first lecture is given before any report is due; the second, after the first report has been corrected; and the third, at the beginning of the term project. We usually combine laboratory sections for these lectures to avoid repetition; each instructor attends with his group, even though the poor soul may have heard the talk a dozen times. Having set up our dates for assignments and lectures, we adjourn until the following week to give the engineers time to draft descriptions of the homework and to allow me to outline my subject matter.

At the second staff meeting, the first chore is to check the wording and slant of the short written assignments. We make doubly sure that the pieces themselves are clearly written and that the student is given an accurate picture of the intended reader (usually a hypothetical fellow-student with the same general engineering background as the author's). We also spell out the type of report we want and provide an outline of organization. No attempt is made to disguise the fact that the assignments are classroom assignments. But we do point out that they are *engineering* assignments, not simply exercises in composition.

Next we review my lectures. In brief, the material covers the basic principles of sound reporting: planning the report, organizing the evidence, writing the rough draft, and revising. The main purpose of the review is to have a meeting of the minds on what we hope to accomplish. But we also wish to refresh the younger instructors on editorial policies and procedures, especially so because they are charged with grading two of the three short reports, for writing as well as for technical content.

The first written assignment is due at the end of the third week. I correct these reports for writing, review them at a meeting of the editorial board, then hold conferences with the authors. I also meet individually with the instructors after they have corrected the second batch of assignments, and we hold dry runs on their conferences with the authors. For the third batch, the editors consult me only on papers which they have

failed. Naturally, if they have any questions they can always give me a call or drop into the office.

To provide the students with a practical reference, we usually compile a brief set of notes on technical writing. This mimeographed booklet is distributed at the first lecture. It describes report format and organization, reviews the major pitfalls of grammar, and suggests ways to eliminate wordiness, add force, and achieve proper pace and timing.

Two more joint staff meetings are held during the term: one to discuss the formal project reports and the other for a course postmortem. I will not bore you with the minutes of these meetings, but I will describe the group projects. Their purpose is twofold: to enable the student to undertake an engineering problem of greater maturity than the conventional laboratory exercise, and to acquaint him with the preparation of a major technical report. The engineering staff select four or five projects from the Institute's current research program; senior faculty members specializing in the particular fields of interest are enlisted as sponsors, instructors as project leaders.

Students spend the last six weeks of laboratory time on the project of their choice, the formal report being due at the end of the sixth week. The following points are of particular importance concerning these reports:

1. The subject matter varies widely.
2. None of the problems has a previously determined answer.
3. All subjects are sizable enough for a writer to get his teeth into.

The processes of preparing, writing, and editing the project report are handled as they would be in a competent research department. Outlines and rough drafts are required. The laboratory instructors check the outlines; I read all the rough drafts. At the outset, the students realize the importance of their reports. They are told in writing and verbally that the project work will be judged entirely through the report and that the grade for a project counts one-third of the course grade.

During the project, my door is kept open one afternoon a week for casual consultation, and at other times by appointment. But my main contribution to the effort is the scheduled conference I hold with each student after I have inspected his rough draft. Conferences last from a half hour for the good writers to an hour for the poor ones. Frequently I require a partial rewrite and an additional conference; infrequently I ask for a complete revision.

The grading of the final report is strictly a function of the engineering staff. The instructors assign two tentative grades to each report: one for technical content and the other for the writing. The split is two-thirds for content, one-third for writing. The course head then reads all the reports and posts the final grades. He seldom changes a grade, and then only after a conference with the instructor. But the instructors prefer not to be the final authority, since, next to the bachelor's thesis, the project report is the undergraduate's biggest technical writing job.

Summary

So much for the example. Each course or department modifies the details to fit its own requirements, but the differences are small. Those in charge agree that the key points of the plan are the active participation of the engineering instructors and the personal attention and informal supervision of the English teacher. I should like to add a third. The attitude of the engineering head is most

important to the success of the program. Unless he is 100% for it, the effort can fizzle. Happily, all of the "brass" I have worked with have been as eager about the writing phase as I.

From the point of view of the Humanities Department, the plan means a much wider distribution of instruction than would normally be possible. In effect, it gives me twenty teaching assistants a term, without draining a drop from the Department's budget. Naturally, there is always the danger of spreading the service too thin, so we will have to be ready to match any unusual increase in demand with an increase in our own staff.

I have often been asked if the students resent having the engineering instructors criticize their writing. I think not—provided the instructors don't make issues of petty errors or enforce matters of personal taste, *and* provided they don't have the final say on the formal report, where the writing grade counts so much. The first condition, of course, applies to anyone who teaches the subject.

What about the instructors themselves? Do they like the job? Practically all of them accept it as a challenge—principally because their chief convinces them that experience in editing is a professional asset, one they will use during their entire career. The trick is for the writing specialist to give them the correct amount of responsibility so as not to embarrass or discourage them.

And finally, how do we sell the plan to the Engineering Departments? Actually, we don't; they sell it to themselves. What we do is help them tailor it to fit their needs, after they have made the decision.

Sample of Short Report Assignment

Situation: The Department Headquarters has asked Professor Foster to prepare a report on the performance of the York Refrigerator system now being tested in the Mechanical Engineering Laboratory. As you have been assigned to conduct one of the tests, you are asked to submit your findings to him. He will then incorporate the information in his over-all report.

Assignment: Write a memorandum report to Professor Foster. State the problem, identify your specific test, give the results, and summarize the method. Concentrate on a clear, efficient presentation of the results. Do not include a mass of data sheets nor discuss the method in detail.

Typical Term Projects

Evaluation of the Performance of a Glass Heat Exchanger. Sponsor: Professor Clark.

Corning Glass Works has recently introduced a pyrex shell-and-tube heat exchanger for industrial applications. One of these units has been shipped to our laboratory with the request that we run tests to map its performance. The project will involve both analytical and experimental techniques for the study of heat transfer phenomena. The results of this investigation will be a contribution to industrial knowledge.

The Design, Construction, and Testing of a Smoke Generator for Use in Turbo-machine Research. Sponsor: Professor Dean.

The use of streamlines identified by smoke is often an effective and quick method of revealing the essential behavior of a fluid flow. Three-dimensional stream patterns and separation are two phenomena which can be determined easily with smoke but which are very difficult to determine otherwise.

The NACA has suggested the use

of a smoke generator burning oil-soaked cigars. Such a device is to be built by the students and tested against a more elaborate oil-burning rig from the Naval Supersonic Laboratory.

HIGH SCHOOL STUDENT ORIENTATION TO ENGINEERING CAREERS

JOHN J. CUNNINGHAM
and MARSHALL L. MILLER

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Wilmington 98, Delaware

The Engineering Department of E. I. du Pont de Nemours & Company, Inc. last spring played host to over 800 high school students and teachers at their Louviers headquarters building near Wilmington, Delaware. The visits were scheduled over a four-day period at the time of National Engineers' Week. Purpose was to give the students a concept of engineering work in industry. The program consisted of two parts, a 30-minute illustrated talk on engineering work and an hour tour of selected points of interest in the building.

The talk was developed around civil, electrical, mechanical, chemical and industrial engineering fields. Several examples of the work of Company engineers in each field were shown with $2'' \times 2''$ kodachrome slides. Relation of students' courses to engineering applications was pointed out.

The tour featured observation of a digital computer, a soil mechanics laboratory and a model shop. In addition, several exhibits were demonstrated which included a small analogue computer programmed to simulate an aircraft landing, a radiation detector, and stress patterns in a plastic model crane boom.

Selection of participating students was worked out with school authorities in the 25 secondary schools within the local area. Most were either juniors or seniors taking physics or chemistry and had taken mathematics for each year of high school.

Evaluations received from both students and teachers indicated that the program was successful in giving students factual information about the practice of engineering. It is expected that this information will help students in making or confirming their choices of college curriculums and will help teachers in counseling students on career choices.

FACULTY RESEARCH, A DEVELOPER OF CREATIVE TEACHING

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In stating the qualifications of an engineering teacher, the Committee on Evaluation reported: "He should perform creative work whether it be in teaching, writing, research, or professional activities." It is the contention of the following discussion that research inherently demonstrates creativity and to a certain extent is a prerequisite for effective teaching.

The communication of information is recognized as the principal duty of a teacher. The raw materials and tools must be intermeshed in the optimum manner if effective communication is to be achieved, and at this point the teacher must extend his efforts beyond the simple statement of textbook material. A student learns only through his own activities, and psychologically the repetition of factual statements by the instructor is at best a poor stimulus. It is possible for information to be transmitted by this method, but the time required for numerous repetitions and parallel illustrations propagates monotony and results in poor learning efficiency. A student might be more productive if he elected to spend the lecture hour in the library or at home with his text and reference books. W. L. Everitt (JOURNAL, Dec., 1951) stated that the objectives of university training should include: teaching to think, teaching fundamentals, and teaching to achieve action. Research affords the teacher an excellent personal opportunity to become experienced and disciplined in this philosophy.

Experience in production engineering reveals that the achievement of an envisioned finished item requires first class raw materials, adequate tools, and an organized and ingenious method of development. The raw materials available to the teacher consist of *factual information* and *the beginning student*. The informed student represents the finished product of the university, with its laboratories, textbooks, and libraries serving as the tools of learning. The two raw material components must, therefore, be integrated; the teacher is confronted with the responsibility of establishing and developing the plans and techniques to include all pertinent factors. A well-founded method of development will effect the product desired, while an ill-planned one will contribute more to confusion than learning.

Raw Materials

Most authorities would agree that the first prerequisite in formulating an operational method of teaching is the attainment of a thorough knowledge of the raw materials. Technical information can be obtained from experience, text books, lectures, association with other professional people, and research. A thorough knowledge of basic laws and their application is a must for the teacher, but of equal importance is a fundamental understanding of human behavior. It is not sufficient to emphasize only one of the equally important raw material components. Teachers must continually guard against forgetting that students are human beings!

Furthermore, rapport cannot be established if the teacher is derelict in

gaining an understanding of students' interests and problems. To achieve this, a well-balanced teacher must study and develop in the humanities and social sciences. Extensive study of text book and "transaction" material is vital, but when separated from the association with people and a desire for creativity, it proves seriously inadequate for inspirational teaching. As Harold L. Hazen puts it (JOURNAL, Sept., 1953), inspirational teaching requires a balance between intellectual vitamins and essential calories. For the present consideration, the essential calories are envisioned as including a thorough knowledge of subject material and the potentials of the beginning student. The intellectual vitamins are the plans and techniques employed by the teacher to achieve a sound product.

Much could be said concerning the importance of technical literature, practical experience and formal courses in education to the teacher; however, the current presentation is concerned with the contribution of personal indulgence in research to good teaching. Diligent pursual of a research program in the individual's particular field of study may be expected to yield revelations of new principles not yet reported in the literature. The participant will rightfully gain a sense of pride which instills within him a desire to portray his findings to others in an inspirational manner. Such high level enthusiasm for communicating text book material is not probable.

In addition to developing new ideas and an avid professional pride, the participant in research may profit further as follows:

A. Appreciation of experimental methods,
B. Appreciation of accuracy,
C. Understanding of theoretical limitations,
D. Understanding of the restriction of simplifying assumptions,
E. Appreciation of reference and background material,
F. Anticipation of students' questions and misconceptions.

According to this hypothesis, research pursued to foster new knowledge of a subject has a number of corollary products, all of which are important to the teacher, and possibly of even greater significance than the achievement of advanced information in the subject. Educators readily recognize the propriety of the contributions offered by research to the teachers of graduate courses, but too few are aware of the strength that these attributes provide for the undergraduate teacher.

J. T. Rettaliata (JOURNAL, Dec., 1955) effectively discussed the advantages of personal research to the teacher. "Research is the element which adds interest and significance to an educational program and, as such, is a proper and essential part of all education at the college and university level. It is important, alike, to both undergraduate and graduate students. Scientific research will have a lasting effect on the attitude of the student. After being appropriately associated with it he is no longer content with merely attending classes, but rather experiences a creative compulsion to contribute to the advancement of his field of study. This is a worthy characteristic of proper research training."

The undergraduate teacher is cognizant of the fact that, at best, he can expect his students to learn only a fraction of the material present in the literature and questions the necessity of his obtaining advanced knowledge in his major subject as a supplement to the literature. In parallel to the student's inability to absorb totally the vast store of textbook information,

the teacher must be aware of his own limitations in propagating all the facts he himself knows. His knowledge of the subject must be many times what he expects his students to learn and should extend into the pioneer and still controversial fields. If the undergraduate student is permitted to accept a textbook presentation as authoritative and complete, the teacher's longest lever for stimulating creative thinking is lost.

It cannot be denied that both the gaining of new information and a strong challenge for creative thinking are invoked by appreciation for experimental methods, the understanding of theoretical limitations, and a critical evaluation of salient assumptions. All of these aids are available to the teacher through personal research in his field of interest. Basic research affords an opportunity for him to face problems which require extensive organization and development. A successful solution leaves in the mind of the participant a lasting impression of fruitful techniques and information which either consciously or inadvertently is reflected in his teaching. Research experience inmmeasurably aids the teacher in apprehending students' problems.

Questions

At this point the question may be raised: Is research in an individual major field sufficient to give the teacher the necessary growth in understanding the personalities of his students? It is seemingly obvious that a mechanical engineer at best might have only a limited aptitude for the fundamental creative work in education or psychology which is necessary for continued improvement as a teacher. On the other hand, if he has learned the value of research along with the corollary disciplines, and has a keen interest in people, he will at least have an appreciation for the results of research in education and a willingness to adopt these findings for the benefit of his teaching.

The possession of a sincere interest in people is probably the first prerequisite for a good teacher. Sometimes those highly productive and successful in research accomplishments or writing do not exert a parallel effort to achieve a growing understanding of human behavior. In addition, they will probably have little interest in civic or cultural activities, and are the individuals who become impatient with students and therefore could probably contribute more to society while serving in a research laboratory or industry rather than as a teacher.

Use of Tools

Now if the equivalent importance of subject knowledge plus an understanding and appreciation for the students' problems is accepted as the initial objective in the process of good teaching, the next step in developing our product, the informed student, is an evaluation of the tools required. In the process of teaching, available tools include textbooks, reference material, visual aids, the class room and the laboratory. Many facts must be considered in establishing a program utilizing these facilities effectively in the process of teaching, but again only the contribution of the teacher's personal research activities will be discussed. How can research expedite the use of teaching facilities which are to be considered as the tools of production?

An understanding of the relative value of available tools is a necessity, and research can contribute effectively in achieving this understanding. Some principles may be taught more readily through laboratory exercises and others through textbook and library assignments. Hence how can

one teach experimental methods and attitudes without having experimented with problems sufficiently difficult to challenge him? Laboratory exercises may seem routine to the teacher, but to the student they should be real problems challenging his creative ability. The teacher can achieve this atmosphere only if he has confronted, through research, the more difficult problems that afford for him an opportunity for creativeness.

A parallel argument can be made for textbooks and reference material. New and improved textbooks and technical literature originate and grow with the desire for creativity which is fostered by research. Should research activity cease, textbooks and reference material would become impoverished. Indeed, many of our teaching tools are the direct fruits of research, and contributing individuals are in a better position to use these aids to the best possible advantage.

Teachers of engineering courses could profitably devote considerable time to study in the field of educational psychology. Because learning is associated with a behavioral change and must be invited, not ordered, certain stimuli are necessary to prompt learning. Therefore it behooves a teacher to study the effectiveness of various stimuli for learning and choose those tools most appropriate for his particular subject. To achieve optimum ultimate results, the teacher should experiment with a diversity of techniques and must frequently sharpen his tools. Experience in the organization and execution of a research program will also be applicable and valuable in improving one's teaching program.

The Finished Product

The finished product is considered to be the student who has been transformed into an informed, enthusiastic, self-confident, but curious individual. He has gained basic information about the subject, eagerly desires to advance his knowledge, and furthermore is anxious to build with his new possession. A balance of these qualities assures continued professional development and freedom from intellectual starvation.

To achieve a graduate of high quality, the responsibility of the teacher in utilizing all resources to the best possible advantage while directing the *production* process becomes paramount. Engineering educators should recognize and accept the challenge that the teacher is a project engineer in every class just as he would be in the design and development of a new mechanical or electronic component of an "atomic airplane." He must know the raw materials, the tools, and envision the finished product desired. He is to attain the objective envisioned by use of his available resources. Needless to say, research will be the "password" in any new engineering development, and as the "project engineer of the class room," the teacher can find a parallel aid from research activity.

This point of view concerning research is supported by Dr. L. A. Du Bridge, President of California Institute of Technology. "In short, if the goal of a university is to help men learn more and to help men understand more, then the place and purpose of research becomes obvious. Research is essential to the fulfillment of the university's mission. However, the research undertaken must be devoted solely to achieving that mission —achieving understanding." [1]

[1] Address June 15, 1954, at the 50th Anniversary Celebration of the Founding of the Enginering Station of the University of Illinois and Iowa State College.

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OPPORTUNITY FELLOWSHIPS FOR 1959–1960

The John Hay Whitney Foundation has announced a group of fellowships "to give opportunity for special experience or advanced study to outstanding individuals who might otherwise not be able to reach their fullest development or to make their fullest contribution." These Opportunity Fellowships are open to citizens of the United States, including residents of territories, who have given evidence of special ability and who have not had full opportunity to develop their talents because of arbitrary barriers such as racial or cultural background or region of residence.

Candidates are expected to be mature enough to have given positive evidence of superior promise, yet young enough to have their careers before them. Those under 35 are given decided preference.

The fellowships are open not only for academic study (graduate) but for other types of training or experience. Applicants for apprenticeships in specific areas are welcomed, but those interested in such programs should write the Foundation for further information.

Awards are for a full year of serious work, and in special cases may be renewed for a second year. Awards normally range from $1,000 to $3,000. They are made annually on the basis of formal written applications by the candidates on forms provided by the Foundation. Complete applications must be filed not later than November 30 and the results will be announced late in April.

Inquiries should be addressed to:

Opportunity Fellowships
John Hay Whitney Foundation
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CITATION FOR HONORARY MEMBERSHIP—1958

Presented at the 66th Annual Meeting in Berkeley. Honorary Membership is voted by the General Council of the Society for "eminent service to mankind in engineering education or other engineering fields." Dean Dougherty was President of ASEE for 1954–55.

NATHAN WASHINGTON DOUGHERTY

Educator, Engineer, and Public Servant

"For over four decades you have occupied increasingly responsible positions both in the teaching and the practice of engineering.

"Throughout this period you have had a high regard for ethical practices, and have assiduously taught both the technical principles and the broad educational aspects of the profession.

"In addition, you have been a participant in many civic activities, and have served your community and profession with distinction in the field of Engineering Registration and Licensure.

"You have established an outstanding record of service in the professional and technical societies of your calling.

"In recognition of this noteworthy career, the American Society for Engineering Education has been pleased to elect you an Honorary Member of the Society."

In accepting the honor, Dean Dougherty said:

"President Lindvall, it is a great honor to respond to this optimistic citation. It is a double honor to be chosen at this time: first, by association in the selection, and second, to be selected by my friends and colleagues. To hold their esteem, when I have worked in their midst, is distinction which pleases me beyond measure. To be a member of this society gives high reward, but to be thus honored by the members is reward indeed.

"I must say that there are a hundred members who are just as deserving and who could wear this toga with equal dignity and appropriateness, yet I am happy to take this as a personal selection and to bask in its regard and distinction. Mr. President, many, many thanks."

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DWIGHT DAVID EISENHOWER

Soldier, Educational Administrator, Statesman

"Following your distinguished career in the United States Army, culminating in the Supreme Allied Command in World War II, you have taken a noteworthy part in national, international, and educational affairs.

"Your election to the Presidency of Columbia University, a unique position for a professional soldier, was a rare tribute to your personal and intellectual qualities.

"Your unselfish and farsighted statesmanship has guided this country during an exceedingly trying period of international relations and world peace.

"During your service as President of the United States you have exhibited unusual interest in education, and have initiated numerous types of action to improve our educational system.

"In recognition of this noteworthy career and of these varied interests, the American Society for Engineering Education has been pleased to elect you an Honorary Member of the Society."

In acknowledging the honor, President Eisenhower sent the following message to Society President F. C. Lindvall:

"Please give my greeting to all attending the annual meeting of the ASEE and my grateful thanks for your citation of honorary membership.

"The effect of education on our young people is of primary importance to the nation. In this vital field, the contribution of engineers and engineer educators has done much to strengthen the breadth and quality of our intellectual resources. Best wishes for a fine meeting."

THE Y.E.T. PAPER CONTEST

First Place

L. BRYCE ANDERSEN, the first place winner, is a twenty-nine year old assistant professor of chemical engineering at Lehigh University. He previously taught at the University of Minnesota, where he received his B.S. and M.S. degrees, and the University of Illinois, where he received his Ph.D. degree. His particular fields of interest are mass transfer and nuclear engineering. The title of his paper is "On the Edge."

Second Place

THOMAS H. ROCKWELL is the second-place winner for the second consecutive year, and is the only repeat winner in the history of the contest. He is twenty-nine years old, and is an assistant professor of industrial engineering at Ohio State University. He has worked in industry for two years and served the same length of time as an officer in the USAF. The title of his paper is "The Senior Engineering Student Views Teaching as a Career—A Pilot Survey."

Honorable Mention

JAMES M. MOORE, Assistant Professor of Mechanical Engineering, Clarkson College of Technology, "Honors Programs—Practical in College?"

ARTHUR H. FRIETZSCHE, Assistant Professor of English, Utah State University, "The Engineering Teacher as Communicator."

CHARLEY SCOTT, Professor of Mechanical Engineering at Mississippi State College, "Help Wanted: Engineering Teachers."

EMPLOYMENT OUTLOOK FOR TECHNICIANS A GOVERNMENT REPORT

Employment Outlook for Technicians, a report on technicians who work with engineers and physical scientists, was released in June by the U. S. Department of Labor and the Veterans Administration. The publication describes the work of technicians, their training, and how new workers can find technicians' jobs. The latest earnings data are presented as well as information in the industries and areas where these jobs are located. The report should be of interest to those concerned with technical institute type of education, and it might be of particular value to those engaged in counselling in this area.

Listed as VA pamphlet No. 22-1, the report is for sale by the Superintendent of Documents, Washington 25, D. C. at 25 cents a copy.

ON THE EDGE

First Prize, National YET Paper Contest, 1958

L. BRYCE ANDERSEN

Assistant Professor of Chemical Engineering
Lehigh University, Bethlehem, Pennsylvania

A morality play on the problems of the young engineering teacher.

Cast of Characters

The Teacher: Young, naïve, and disillusioned.
The Researcher: Young, brilliant, starry-eyed.
The Consultant: Somewhat older, and rather tired.
The Producer: Middle-aged, well-known, confident.
Wisdom: Very old, perhaps a department head.

The Scene: At the edge of a precipice on a dark, quiet night (as is the custom in morality plays, the characters and scene are symbolic. Here the precipice symbolizes the choice between teaching and working in industry. The characters will speak more frankly than in real life).

The Play

Wisdom: Stop! Don't jump!

Teacher: Why not? There's nothing left for me here.

Wisdom: But at least let us talk it over before you do anything so drastic.

Teacher: Well, I don't have much time, and I *have* thought this out—in fact I've thought about little else in the last year. What more is there to say? I'll never be a success in teaching engineering, so I might as well get out now.

Wisdom: But I've heard good reports on your classroom teaching. And you were so enthusiastic when you started to teach four years ago. What happened?

Teacher: Oh sure. I was enthusiastic about teaching when I started. I remember deciding to make teaching a career when I was a junior in college. That's why I went on to graduate school for a Ph.D. And I do love teaching, every minute of it; if only they would let me do it. My first year here was the most enjoyable of my life. Of course, I was terrifically busy, preparing for new courses and getting settled with my family, but I loved it. I may have neglected my family a little that first year, to do a really first-rate job on my new courses.

Wisdom: Then why do you want to give all of it up now?

Teacher: Why? Because it turns out that teaching isn't enough. I'll never be successful on that alone. I'm told that good teaching is hard to evaluate, and that promotions are based on more measurable criteria—like research publications and consulting. Now I have nothing against research and consulting, but I want to teach. In order to maintain the standard of teaching which I consider a bare minimum, I have to spend all of my time on teaching. With three or four courses and twelve contact hours each term, I work at home several nights a week to keep up.

Wisdom: If you were more interested in research, you might find the time.

Teacher: Find the time? Of course, but at the expense of my teaching. If I have to neglect my teaching to get ahead, I would rather get out of

the field. I think it is too important to do less than the best possible job.

Wisdom: Well now, it can't be that bad. There are many men in engineering education who have combined teaching with a successful career in research and consulting. Let's talk with them. Ah, here comes Researcher now. (to Researcher) You have been at the University as long as Teacher, and you were promoted last Spring. To what do you owe your good fortune?

Researcher: My good fortune? It was hard work. I spend every minute of my spare time on my research. I've published six papers in the last three years.

Wisdom: Are you happy in your work?

Researcher: Definitely. I went into teaching because I wanted to do my own research, not what I would be told to do if I were in industry. I have two research grants from the more progressive foundations and five graduate students. I'm working on exactly the fundamental research I'm interested in. What more could I ask for?

Teacher: And how is your teaching coming along?

Researcher: All right. Why do you ask?

Teacher: When do you find time to prepare your lectures, to work out homework assignments?

Researcher: Well, I admit that twelve contact hours are too many. They can't expect us to make adequate progress if they load us with so many teaching duties. I'm going to ask for nine hours next term, so I can spend more time on research.

Teacher: But what about your teaching?

Researcher: Well, the first year I spent a lot of time whipping my courses into shape. Since then they haven't taken much outside time. I use the same notes and assignments.

Teacher: And do you work out the assignments yourself?

Researcher: Of course not. Who has time for that? Besides, the *students* are supposed to work them out—*I* know how.

Teacher: But how can you explain them if you haven't done them? How do you know exactly what principles the longer problems illustrate if you haven't gone over them?

Researcher: I read over the problem and discuss the solution in general terms—or I can have one of the students put the solution on the board.

Teacher: I don't believe the students ever gain confidence in their work if they can't compare it with a complete, correct solution. They often get hung up on some small point. They may know the generalities as well as the instructor, but they still can't do the problem. Besides, you expect a complete solution on the exams; are the students asking for too much for a complete solution from you in class?

Wisdom: Teacher is thinking of leaving us, because he doesn't think he can be a success here. What do you think?

Researcher: We started here at the same time, but he hasn't developed much of a research program. He keeps up on the technical journals; better than I do, in fact. He is always pointing out articles that bear on my research, but he can't seem to get started on his own.

Teacher: I read the journals to keep up on advances in my field. After all, I want to be up-to-the-minute in my teaching. To keep up in the broad area of engineering takes a lot of time.

Researcher: But why don't you do some research?

Teacher: Because I find it dull and unchallenging. You may like it, but I don't. Don't misunderstand me. The results of research are important and interesting, and of course someone must do it; but I don't care to. It seems to me it is just a matter of interest.

Researcher: Well, when the time comes for promotions, the Dean can count the papers I've published, but how is he going to know your teaching is so good? The students might be able to tell him, but who listens to students?

Wisdom: Let's get Consultant's views. I see he is coming now. Tell me, Consultant, what makes a successful engineering teacher?

Consultant: That depends upon what you mean by successful. I have developed a profitable consulting practice and am making direct contributions to industry. My research is related to my consulting, and I can add many actual industrial experiences to my lectures.

Teacher: But do you have time for teaching?

Consultant: Well I wouldn't want this to get back to the Dean, but I sometimes wish I had more time for my teaching. Oh, I can bluff through a lecture, after I've been gone for a day or two on a consulting trip, but I really doubt that the students get what they should out of lectures like that.

Wisdom: But the University allows its faculty only one day a week for consulting.

Consultant: Yes, and I'm gone only one day. But of course I spend a good deal of my time at school working on problems which arise in my consulting, and on the several research projects which are of interest to the companies with which I am working.

Teacher: If you think you should spend more time on teaching, why don't you drop part of your consulting?

Consultant: Young man, I have four children whom I want to send to college. Obviously, I can't do it on my University salary, so my consulting is an economic necessity. I couldn't cut it down if I wanted to. As your family grows, you'll run into the same problem.

Teacher: Yes, I know. That's another reason I'm going to jump.

Consultant: But you have been encouraged to take on outside consulting. Why haven't you?

Teacher: Because teaching is a full-time job, as I said before. You are effectively working half-time in industry. If I were interested in that, I might as well do it full-time, and get paid an industrial salary.

Consultant: Certainly some industrial experience would improve your teaching.

Teacher: You're right. I've worked in industry for the last four summers, and I've found the experience very valuable and interesting.

Wisdom: Perhaps Producer has something to contribute.

Producer (who has been standing in the background for several minutes): You needn't equate an adequate salary with industry alone. My income has been in the five figures for years, and I seldom leave campus.

Wisdom: And you are probably the best-known member of our faculty. Your name appears on my papers each year from your National Drilling Mud Research Institute here on campus.

Researcher: But it is hardly proper research—it is too applied for a university.

Producer: See here young man, the University has a duty to provide in-

dustry with fundamental knowledge. Our research is basic, even though most of it is related to drilling muds.

Teacher: Does the University have a responsibility to its students?

Producer: Of course. I teach a graduate course in my specialty once in a while, and I have fifteen graduate students working in the Institute. They really get a good education in *practical* research, one they can use when they go to work in industry.

Researcher: Sounds like you are running a trade school. You've simply moved a segment of industry into the University. Your staff, with ten full-time employees and fifteen students, dominates your department and makes it impossible for a new staff member to get his own research started.

Producer: What do you mean? I always have room for one more worker. Any of the younger members of our staff can work part-time at the Institute, and get paid for it, too.

Teacher: But why should they receive pay above their regular salary? I work full-time on teaching. If I neglected it, and worked part-time with you, I'd get paid more. Is that fair?

Producer: Certainly it is fair. We are making a real contribution to industry, and they pay us very well. I must run along now. I have a meeting with the Institute's Board of Directors.

Teacher: You notice he never mentioned undergraduate students. I doubt that he knows they exist. (To Researcher and Consultant): Certainly your work is important to the University, but you seem to neglect your teaching to do it. When do you find time to work with students individually? They always come to me when they can't find you in your office.

Consultant: Perhaps I don't spend much time in my office, but I don't believe in spoon-feeding the students. They've got to learn to think for themselves.

Teacher: If you carry that argument to its logical conclusion, the students don't need any help, except a book; and teachers become superfluous.

Researcher: I must get back to the lab. (Aside to Wisdom): I wouldn't worry about Teacher's jumping. He is rather poorly oriented anyhow. We can replace him with someone who can make a real contribution to engineering science.

Consultant: (To Teacher): I hope you stay with us. We need you. I wish I could afford to spend more time on teaching. Well, I have a plane to catch.

Teacher: They've all gone, and they haven't said anything I haven't heard many times before. I appreciate your concern, Wisdom, but you haven't changed my mind. I still believe that the primary function of a university is the education of its students. If I participated in the activities of these other men, I would be neglecting my primary responsibility, and I cannot do that. If I am not to be allowed to teach properly, I would rather not teach at all. Goodbye! (He jumps.)

Wisdom: (To the audience) We didn't save him. You may feel that our characters have been extremes of their type. And yet these types do exist. Certainly, Teacher was too naïve and idealistic. And yet he has a point. Good teaching is not easy to evaluate. Researcher, Consultant, and Producer will be promoted more rapidly because their activities are more easily evaluated quantitatively. The Dean can count publications more easily than he can count well-educated students. We need not dwell on faculty salaries, but one wonders how much

better engineering teaching would be if teachers were not forced by economic necessity to vitiate their energies on work not directly related to their teaching.

Is the young man who is solely interested in teaching intellectually inadequate? Must he have other activities? Cannot teaching be a full-time job? Can promotions be based solely on excellence in teaching? These questions we must answer, for until we do, we will continue to lose some of our best young teachers to industry, simply because they are too interested in their teaching.

If we are to develop engineering faculties, we must recognize and reward excellence in teaching, just as we reward excellence in any other area of intellectual endeavor at the University.

DR. WILLIAM FREDERICK DURAND

Dr. William Frederick Durand, "dean of American engineers," pioneer in the field of aviation and a life member of ASEE, died on August 9 after a brief illness. He was 99 years old.

Editor of and contributor to the six-volume definitive work of the principles of gases in motion, *Aerodynamic Theory,* his contributions to hydrodynamics and aerodynamics are considered fundamental in the field. An early publication was his *Resistance and Propulsion of Ships,* which eliminated, for the first time, most of the guesswork in making propellers. During World War II he organized the American effort to design and produce jet engines.

Dr. Durand was one of the original members of the National Advisory Committee for Aeronautics, which he also served as chairman. He was a past president and Honorary Member of the American Society of Mechanical Engineers, and a recipient of the Guggenheim Medal and the John Fritz Medal in 1935. In 1944 the National Academy of Sciences presented him with the John J. Carty Gold Medal for notable leadership in engineering and in 1945 he won the ASME Medal for "his contributions in hydrodynamics and aerodynamic science." Dr. Durand was also the first recipient of the Wright Brothers Memorial Trophy awarded by the National Aeronautical Association for "significant public service of enduring value to aviation in the United States."

Dr. Durand was born at Beacon Falls, Connecticut, in 1859. He graduated from the U. S. Naval Academy with honors in 1880. In 1891, after taking a Ph.D. degree from Lafayette College, Dr. Durand took charge of Cornell University's Graduate School of Marine Engineering. He had previously taught at Michigan State College. He joined the faculty of Stanford University in 1904 and later became head of the Department of Mechanical Engineering. He served in numerous government posts.

THE SENIOR ENGINEERING STUDENT VIEWS TEACHING AS A CAREER–A PILOT SURVEY

Second Prize, National YET Paper Contest, 1958

T. H. ROCKWELL

Assistant Professor of Industrial Engineering
The Ohio State University, Columbus

For the only time in the history of the Contest, an author has taken second place for two consecutive years—congratulations to Professor Rockwell!

One of the facets of the engineering faculty shortage which has received little attention is the question of student attitude toward teaching as a career. Prompted by informal discussions with senior engineering students, the writer conducted a free-response pilot survey to sample these attitudes. Within the limits of their interpretation, the reported opinions are illuminating. Despite the little effort made to acquaint him with the opportunities in teaching, the senior engineer has *definite* ideas on the merits of teaching as a career and many of his responses indicate a keen awareness of the advantages and disadvantages of this vocation.

Of the 74 students surveyed, 40 per cent indicated that they had considered teaching as a career. Over 20 different advantages were ascribed to teaching, with personal satisfaction and accessibility to new knowledge listed with the greatest frequency. Of the 18 distinct disadvantages to teaching mentioned, lack of adequate salary was reported by all students. Ninety per cent of the sample indicated personal satisfaction as the chief reason why they thought their instructors remained in education. Results further suggest that engineering teachers have a strong influence on student attitude.

Unfortunately, this influence has not been sufficiently utilized in attracting qualified students into the educational profession. Publication of salary information, elective seminars in engineering teaching, and freshman and senior survey courses are just a few of the means by which the student can become acquainted with the opportunities in teaching. If student attitudes toward teaching can be accurately gauged, a national study along the lines of this survey would be a significant step in alleviating existing and future shortages of engineering faculty.

Introduction

Even before the age of sputniks and their impact on our society, engineering educators have long recognized that a shortage of qualified teachers exists (3) (4). College enrollments are expected to double in the next ten years and technological comparisons with the USSR will probably magnify the problem. Dire predictions can be found both in technical journals and in the public press. While some may argue about the magnitude of present and predicted engineering faculty shortages, most agree that a shortage does indeed exist. A glance at student-teacher ratios shows a definite increase since 1945 (2). Losses of faculty to industry, although

not particularly heavy, have only added to the problem (1).

In the light of this situation, the foremost question is how will we secure qualified men to staff our engineering college faculties? An indirect solution would be to increase the utilization of existing staffs. Suggestions have been made to relieve the engineering instructor of routine clerical and administrative duties (2). The employment of technical institutes, second-shift teaching schedules, and the use of closed-circuit television may also make better use of our existing faculties. But these are only stopgap measures. The tide of engineering enrollment can only be met by bringing more and better men into engineering education.

There are two principal sources of manpower—returnees from industry and graduate students in engineering. The contribution from the former will be necessarily limited until teaching positions can favorably compete financially with industry. The more practical solution lies in encouraging outstanding engineering graduates into advanced study and ultimately into teaching. The question is how?

One approach is to find out what the student thinks about teaching as a vocation. Before we can sell the qualified student on teaching and graduate work, we must stress those characteristics of teaching which appeal to him and remove misconceptions that may exist in his mind.

The survey was developed with three objectives in mind:

1. to determine the possibility of gauging student attitude toward the merits of the teaching vocation and the mechanism by which such measurement could be accomplished;
2. to describe the general range of responses, strong attitudinal positions, and their implications;
3. to indicate how such information might be useful in encouraging the better student to consider teaching as a career.

It must be emphasized that the survey was primarily exploratory, and its results are not necessarily representative of the average senior engineer.

The Survey

Selected on the basis of their accessibility, the 74 students for the survey were taken from four engineering classes and were composed of senior male engineering students majoring in industrial, mechanical, welding, and chemical engineering. The ages of the students ranged from 20 to 30 years and their cumulative point-hour ratios varied from 1.9 to 3.4 (on a scale where 4 = A, 3 = B, and so forth). The subjects were given 20 minutes to complete the survey during a regular course hour. No advance notice of the survey was given, and no attempt to influence answers was provided in the preceding instructions.

Free-response type questions were used in the survey to offer the student complete expression of his opinions. Even failure to respond was significant information for the purposes of the survey. Using this type of question necessarily resulted in a wide range of responses and made classification and interpretation of the reported information difficult. As shown in the figure below, the students were given five questions, with a short paragraph preceding the questions explaining the purpose of the survey. The student was also requested to provide additional information such as age, cumulative point hour ratio and major department.

SURVEY FORM

One of the serious problems facing this country is that of developing the

quality and quantity of university faculties to meet increasing college enrollments. This is especially important in technical education in light of recent Russian scientific and engineering achievements. One of the chief sources of supply to the engineering faculty is the engineering graduate. Since you are at that stage in your life which calls for a decision regarding your choice of career, we are interested in sounding out how the teaching career looks to you. Please answer the following questions.

1. What do you consider to be the advantages to a teaching career in engineering? List in order of importance .....
2. What do you consider to be the disadvantages to a teaching career in engineering? List in order of importance .....
3. Why do you feel the engineering faculty with whom you are most closely associated keep their positons in view of the present demand for engineers in industry? List in order of importance .....
4. Have you ever considered engineering education as a career? Yes. No.
5. If you have decided against a teaching career, what were the reasons behind this decision? List in order of importance .....
6. Please provide the following supplementary information.
   Age ——. Cumulative Point Hour Ratio ——. Major ———. Degree expected ———. Do you intend to do graduate work ——.
   Do not sign your name. Any comment relative to the questionnaire itself should be written on the back of this sheet.

Survey Results

The first significant result of the survey was the magnitude of response. To the first question only one student failed to give at least one advantage to teaching, and 81 per cent gave at least two. The poorest response was to the last question (and perhaps would be expected as the student's motivation may have waned), yet even here the results were encouraging. Ninety per cent provided one response and 62 per cent provided at least two.

As was expected from open-type questions, the range of opinions varied considerably. This necessarily made classification difficult since many responses had to be interpreted to allow for grouping. Although the students ranked their responses to a question in order of importance, there was no way in which these priorities could be combined in a single criterion, since a common scale of importance did not exist. Hence, one can only report the frequency with which a particular response was listed first, second, third, or fourth in importance.

To the first question there were 21 different advantages ascribed to the engineering teaching profession, including such responses as the proximity to new knowledge and techniques, easy life, personal satisfaction, opportunity for consulting, independence and the lack of pressure. The second question revealed 18 different disadvantages, including lack of pay (mentioned by all) little chance for initiative or advancement, no tangible results, too much politics, and loss of real-life experience. To the third question there were 16 different responses, such as the ability to inspire others, lack of pressure, university climate, desire for advanced education, and security. The last question revealed 13 different responses, including salary considerations, limitation on initiative, insufficient grades, and routine and repetitious work.

The most frequent responses to the five survey questions are presented in the table below. Percentage figures are given for those who listed a response category first or second, and the per cent who listed the category regardless of the ranking assigned to

it. To Question 1, categories (a) and (d) were listed as either first or second in importance by the most students. Category (c), "social position," was listed by 41.9 per cent of the sample, but chiefly as third or fourth in importance. Surprisingly absent from the top responses was job independence, recorded by only 8 per cent of the sample,

The fact that over half of the sample listed "personal satisfaction" seems to bear out the fact that the student sees an intangible, yet desirable reward to the teaching vocation. Question 3 reflects the responses given in Question 1, except that personal satisfaction is emphasized much more. Question 2 heavily accents salary as the chief disadvantage to a teaching career. All of the students listed this category.

Another frequent response was category (i), "little chance for advancement,"—this borders on the salary problems. To the fourth question 40 per cent of the students indicated that they had considered teaching as a career. (It is difficult to say how much serious consideration was given, however.) The response to Question 5 was similar to that of Question 2 except for the inclusion of category "s" which indicates a realistic self-appraisal by many of the students.

In general, the responses of the better students (cumulative point hour above 2.7) reflected the overall attitude of the entire sample. The chief difference was noted in Question 1. Here 23 per cent of the entire sample listed "accessibility to new knowledge" as the chief advantage to teaching, while 40 per cent of the better

TABLE I

SUMMARY OF MOST FREQUENT RESPONSES TO THE SURVEY QUESTIONS

Response Category	Per Cent, Listing the Categories *1st*	*2nd*	*Total*
Question 1. (Advantages to a teaching career)			
a. Accessible to new knowledge	23.0	20.8	60.8
b. Opportunity for research	6.7	10.8	24.1
c. Social Position, prestige	4.1	13.5	41.9
d. Personal satisfaction	33.8	16.2	53.2
e. Free time, lack of pressure, easy job	10.8	6.7	35.0
f. Security	8.1	6.7	29.6
Question 2. (Disadvantages to a teaching career)			
g. Inadequate salary	63.5	28.2	100.0
h. Requires too much education	4.1	8.1	20.4
i. Little chance for advancement	6.7	20.5	33.8
j. Work repetitious	4.1	9.51	20.4
Question 3. (Why their own instructors are in teaching)			
k. Want to advance education	1.9	13.1	37.8
l. Social position, prestige	1.3	14.9	21.6
m. Personal satisfaction	58.0	19.0	90.5
n. Security	4.1	8.1	19.0
Question 4. (Had the student ever considered teaching as a career)			
o. Yes			40.5
p. No			59.5
Question 5. (Personal reasons for not pursuing teaching career)			
q. Inadequate salary	29.2	18.6	57.0
r. Requires too much education	9.3	12.1	19.0
s. Grades too poor (not qualified)	22.7	6.7	36.0
t. Little chance for advancement	5.4	4.1	10.8
u. No interest in teaching	14.9	6.7	29.2

students gave this category top preference. For those students who did possess grades which would permit graduate study, the chief objection to teaching was the problem of financial reward.

A final observation from the results of the survey is one which has significance. There was close agreement between Question 1 and Question 3, as can be seen from Table I. This suggests that a student's attitude toward the advantages of teaching stems from association with his instructors.

Interpretation and Significance of the Results

A pilot attitudinal survey of this type necessarily restricts one's ability to make conclusive interpretations of its results. However, as an exploratory approach to the problem, it does permit some general observations. The first question one could pose from a study of this kind is how well do student views agree with what we know about teaching. The basic problem here is that the views toward education by the faculty vary considerably themselves. Each educator has his own set of reasons for choosing this career.

The students' emphasis in Question 1 on personal satisfaction and the ability to inspire others is rather surprising to the observer. In a materialistic society which seems to emphasize the value rather than the obligation in engineering, this response is encouraging. Despite the fact that the phrase "personal satisfaction" is somewhat ambiguous, the meaning is clear when one notes the other responses used. To the student, there seems to be an intrinsic benefit in teaching, something more than money, honor, or material gain, something which satisfies the inner man. Perhaps it is simply the opportunity to help others achieve their goal in life.

Whatever this satisfaction is to the individual student, he ranks it above prestige, accessibility to new knowledge, independence, and the other more tangible advantages of teaching. Second only to personal satisfaction in first choice was accessibility to new knowledge. By the time he reaches his senior year, the engineering student has gone through a gradual evolution. As a sophomore, he was practically ready to solve any engineering problem. As a senior, he begins to realize that there is a wealth of engineering knowledge and method with which he is unfamiliar. Thus, he sees in teaching a means to acquire both depth and breadth in his field. The response category that was virtually ignored was that which many teachers hold dear—namely, their independence. Apparently the student does not perceive this in his association with the faculty.

The response to the fourth question was surprising. Thirty of the 74 subjects had considered teaching as a career. How long or how seriously they had considered it is another question. Yet the figures reported, if they are at all representative, are encouraging, for they suggest that students do have an awareness of the possibilities in teaching. This lends hope of attracting students into the teaching career.

Conclusion

One of the ways in which better students can be encouraged into graduate study and teaching is to inform them of the opportunities and rewards in engineering education. The close agreement of Questions 1 and 3 and the general insight of student response indicates that the teacher has a tremendous influence upon student attitude toward this profession. There is little doubt that the attitude presented by the instructor is reflected in

the student. This suggests that the teacher, especially the young engineering teacher (who because of rank and age is likely to have more contact with the student) should be aware of his responsibility.

Frequent derogatory comments on teaching may quickly extinguish any interest in this vocation that the student may have had. The instructor need not consciously proselytize his chosen career. Enthusiasm for his work, knowledge of his field, and his personal interest in students are constant testimonials for a career in engineering education. The young engineering teacher can influence student attitude because the student sees that here is a person who has rejected the attractions of industry for something he considers more valuable. Despite the demands on his time, the teacher should encourage the better student into graduate school and at the same time suggest that he consider teaching as a career.

There are means to inform students about the teaching vocation. Many colleges have both freshman and senior survey courses which describe various career opportunities in engineering, and yet fail to mention teaching as a profession. In merit programs the better student might elect to take a seminar on engineering teaching. Here various members of the college staff could discuss the pros and cons of the profession. In the light of student concern about salary, steps should be taken to inform him of the actual salary situation in engineering colleges as compared to industry.

It is paradoxical that so much emphasis is given to acquaint the student with opportunities in engineering, even to the point of elaborate placement systems to help the student find the *right* job in industry, yet little effort is expended to acquaint him with a career in teaching. A frequent comment by interested students after this survey was "how can you ask us about teaching when no one has even talked to us about the subject for the five years we've been on this campus?" In contrast to the frequent laments of engineering faculty shortages, this is a serious indictment.

This pilot survey has left many questions unanswered. On the one hand there is the problem of how student attitude is formed on the subject of teaching, and how this attitude changes during the course of the student's education. What are the determiners of student opinion, and to what extent can they be influenced? How can we take advantage of existing attitudes to encourage our better students into graduate study and teaching? These questions support the advisability of projecting this survey into a national study to provide a representative picture of student attitude. A study of this magnitude could reveal attitudinal differences as the student's education progresses.

To permit validity and reliability estimates, a nationwide study could use objective test questions, guided perhaps by the response categories reported in this survey. The influence of student-teacher ratios, major department, age, grades, and other possible determiners of attitude could be developed from such a study. If student attitude can be accurately measured, the emphasis in a brochure intended to encourage students into teaching could be more efficiently directed. Perhaps it is time to examine our real source of teacher supply—the qualified engineering student. By finding out how he views teaching as a career, we can better direct our resources to encourage him into the teaching vocation.

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TEACHING POSITIONS AVAILABLE

CIVIL ENGINEERING STAFF POSITION IN SANITARY AND Hydraulic area. Open only to engineer with M. S. degree. Teaching and industrial experience desirable but not essential. Apply to W. W. Lorell, Head, Department of Civil Engineering, San Jose College, San Jose, California.

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A LIVING TEXT FOR ELEMENTARY THERMODYNAMICS

A. K. OPPENHEIM

University of California
Department of Engineering, Berkeley

Presented to the Heat Power Subdivision of Mechanical Engineering at the 66th Annual Meeting in Berkeley, June 17, 1958.

We are living in a rich and prosperous land. One of the signs of this prosperity is the abundance of printed matter, as reflected, for instance, in the size of newspapers and the multitude of advertising pamphlets which keep us all quite busy each day in the process of their transfer to our circular files. But most amazing of all is the impact this prosperity has on college textbooks.

I do not propose to rejoice or deplore this fact in general. My bone of contention is only with a very small part of this general trend, namely that associated with the texts on thermodynamics. Their supply is indeed fantastic. The bookshelves of any one of us occasionally involved in teaching this subject are indeed seriously overstrained under the avalanche of this supply.

Is this good or bad? There is no question in my mind that it is always better to have than not to have. However, with respect to the availability of texts on thermodynamics, I think that we are already on the other side of the spectrum: we are overabundant, and that is bad.

I would like to present here an argument to demonstrate why I am of this opinion and suggest a remedy for your consideration.

The Argument

There is something unique about the subject of thermodynamics in that, on the one hand, it is a fundamental subject in engineering and, on the other, it participates so fully in the modern progress of science. This feature is illustrated by the evolution of irreversible thermodynamics, as well as by many aspects of modern developments in gasdynamics, thermochemistry, and heat transfer. Above all, however, thermodynamics represents a particular philosophy of analysis and consequently it forms a distinct discipline. As a discipline it should be taught on the basis of a classical text, that is, a text which has passed the test of time and has been adopted by the majority as the correct exposition of fundamentals. Why don't we use such a text? Are the available ones of such character (see bibliograhy at the end of paper) too old fashioned, starchy, unpalatable, and out-dated? Certainly not in their fundamental meaning, but perhaps in their approach to the subject matter, the motivation and applications.

New textbooks, then, serve only one specific function; that is, they keep the fundamentals topical. Unfortunately, in their efforts to be clear and simple as well as topical and interesting, the authors very often over-simplify the issue to such an extent that the exposition of the subject matter loses not only in rigor but sometimes even in truth. In this respect, I am afraid, the situation is indeed deplorable.

We are living in times which—I claim—will be known to posterity as

the age of the text on thermodynamics. Since the subject is philosophical in nature and has a strange individual appeal, especially to teachers, each tends to create his own discipline. Such an undirected and overabundant expansion heads towards nothing better than Babel.

The Remedy

The problem which faces us under the circumstances of such a pulverizing influence is how to crystalize the discipline of thermodynamics. My suggestion is based on the salient feature of the demand which the multitude of the present-day textbooks seems to satisfy: namely, the demand for a topical treatment of the subject matter, a strange demand indeed for a text on a classical subject such as thermodynamics. A form of publication which by definition satisfies such a demand much better is a periodical, not a textbook.

According to this feature, then, we should have a periodical devoted to the fundamentals of thermodynamics, kept up to date with respect to modern outlook, and made available for use as a supplementary text material for the neophytes who are introduced to the subject at the undergraduate level of an American university.

As far as the frequency of such a publication is concerned, we should realize that the frequency of a periodical is inversely related to the profundity of its subject matter. As contrasted to the contents of a daily paper, a weekly journal, or a monthly magazine, the subject matter of the proposed periodical is so profound that nothing less than a yearly would adequately serve its basic function.

As to the subject matter of each issue, I propose that it should have the character of a chapter of a typical American-style college textbook, that is, a chapter containing theoretical introduction, examples, illustrations, problems, and, of course, recommended references. Each issue then would be in essence devoted to a small branch of the subject of elementary thermodynamics. Thus, one year we would publish a chapter on gasdynamics, another year one on heat transfer, or on thermochemical calculations, or introduction to statistical thermodynamics, or maybe even on irreversible thermodynamics and its applications to modern engineering problems, and so on. Each chapter should be contained within a paperbound signature of 16 or 24 pages and published sometime during the summer months to be available throughout the next year for students and instructors alike. Each should be written by an outstanding authority in the field willing to comply with the general rules adopted to make the coverage of the subject matter uniform and applicable to junior level of comprehension. The cost of each copy should be less than $1.00, say, 49¢.

If such a publication would have a sufficiently wide distribution, so that it would be readily available at student book stores, then, I hope, it would be considered by the professor a convenient supplementary material for instruction, as well as by the students a good source of knowledge. As to the authors, they would be given the great privilege of being able to infiltrate the "public" with the Discipline of Thermodynamics.

If such a scheme were initiated, then, I am sure, in a few years at least a good part of the issues would become classics in the field. Just imagine how much would you treasure today such short, concise and introductory chapters as one on the First Law written by Poincaré, one on the Second Law written by Clausius, one on thermochemical calculations by Gibbs, an introduction to statistical

thermodynamics by Planck, to mention just a few.

To sum up, I propose to initiate a periodical devoted to the introduction of the fundamentals of thermodynamics with a single issue published each year, having the format and size of a textbook signature and essentially representing an American-style textbook chapter on some particular aspect of the subject, written, of course, by an outstanding authority. To be more specific, I would start such a series with a chapter on heat transfer, followed by one on gasdynamics and one on thermochemical calculation. The following chapters could be on some sections of these general fields, such as, say, heat transfer by radiation, or thermodynamics of solutions. Then, later—but only later—would I attack the fundamental laws and basic concepts.

This, gentlemen, is the idea of the "living text" which I submit now for your criticism and advice.

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RELATIONS WITH INDUSTRY COMMITTEE'S COLLEGE–INDUSTRY CONFERENCE, JANUARY 26–27

The Relations With Industry Committee's 1959 College–Industry Conference will be sponsored by the University of Houston and will be held on the University of Houston campus January 26–27.

General theme of the conference will be "Industry Speaks Its Mind on Engineering Education." The program is so arranged that Monday morning will be devoted to registration and a presentation of four talks by outstanding speakers on subjects pertinent to the general theme.

Monday afternoon will be divided into four or five concurrent sessions, each led by a discussion panel with opportunity to discuss and evaluate one of the morning talks. On Tuesday morning there will be a spokesman from each of the Monday afternoon meetings to present the opinions and ideas discussed during the concurrent meetings. The conference will end following lunch on Tuesday.

Further information concerning the meeting may be obtained from RWI Chairman Ralph A. Emerson, Industrial Relations Supervisor, E. I. duPont de Nemours & Co. Inc., Wilmington 98, Delaware.

Teaching Tip

THE BLACKBOARD-SLIDE: A NEW VISUAL TEACHING AID

GEORGE J. KENT

Department Chief, Graduate Engineering Training Center
Western Electric Company, Incorporated
Coliseum, New York 19, N. Y.

The method developed and described here is the result of the search for a visual aid technique which would combine the advantages of blackboard and slides and at the same time reduce their inherent disadvantages. The method was developed by the author and demonstrated in December 1957 at the Graduate Engineering Training Center in New York.

The physical principle applied is the discovery that drawings projected from 35 mm. slides on any color blackboard are almost as clear and legible, even in full daylight or artificial light, as those projected on a standard screen. The projected picture must not be too large ($3' \times 4'$), since good illumination is required for it to stand out.

The instructor uses the projected drawing as a background and superimposes his own drawing or changes upon it in white or colored chalks. In this manner, the basically accurate, detailed and scaled projection is supplemented by added information. This can be done easily even by a person without much drafting ability, since the main parts of the drawing already exist.

The projector used in the development work was one provided with a standard 500-watt lamp and an automatic slide changer. The lens, f:4.5, had a 7½-inch focal length, and the distance between the projector and screen was 24 feet. The height of the picture obtained from 2×2 slides (35 mm.) was 35 inches and the width was 51 inches. Because of its relatively small size, the picture was bright and clear even when shown in full light. The unpleasant and distracting switching on and off of class lights was thus avoided. Other projectors equipped with similar optical systems may be used, as long as the illumination is sufficient for local conditions. Yellow chalk is best.

Examples of Use

A few examples provide an insight into the interesting possibilities afforded by this method, which offers highly desirable advantages for engineering instruction of all kinds.

In conjunction with a course in Basic Electronics, it is used mainly for the graphical solution of numerical circuit problems. Suppose that the circuit of a simple triode amplifier is under discussion; students are considering the characteristics of a 6J5 tube (see Fig. 1). The static load line A-B has to be drawn and a quiescent operating point Q defined by determining its coordinates, I_b and E_b.

Usually the instructor draws the plate characteristics as best he can. These are never too accurate unless a great amount of time is spent on the drawing. Because of the inherent inaccuracy, the solution is not convincing and illustrates only the principle rather than the exact and accurate technique which is to be used.

When the new method is adopted,

the plate characteristics of a 6J5 tube are first projected on the blackboard. Then the instructor finds points A and B from the circuit parameters and locates them exactly on the projected characteristics; thereafter, as shown by the dotted line, he draws a straight line through points A and B. Where the static load line intersects the characteristic for the given grid bias voltage ($E_c = -6v$) the Q point is found. The horizontal and vertical lines drawn through Q provide the intersection with the i_b and e_b axes and therefore the needed and accurate answers I_b and E_b.

The main advantage of the method now becomes apparent. The instructor works with the same characteristics as the students, and his graphic solution is as accurate as theirs made with printed characteristics. However, the instructor's solution is much more authoritative and convincing when he uses the new method, since it is exact and quantitative.

If the instructor wants to emphasize the theory behind the solution, he merely draws two lines over the coordinate axes and switches off the projector's light. Now the somewhat distracting background of the tube characteristics disappears and the main graphical construction of the load line remains on the board. The basic principle can then be easily discussed.

When explaining block diagrams of complex electrical equipment with many switching alternatives, the method is particularly useful. The basic arrangement of blocks with all the titles, terminals and switches is projected on the blackboard without any interconnections. The instructor then draws the connections between blocks and explains the operation. The students have reprints of the same block arrangement available and complete their block diagrams simultaneously.

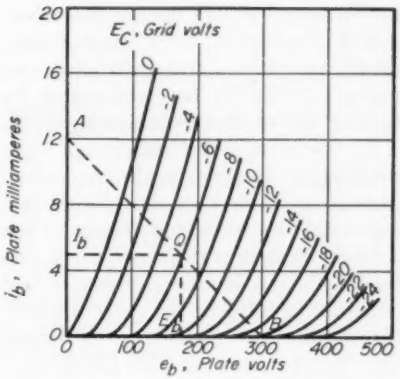

FIG. 1

When the instructor replaces a set of connections by another in a different color, the students follow on another reprint or on the first sheet with different colors. Much work and time are saved, and the resultant diagrams are neat and clear. Students should be provided with reprints before class.

The method also lends itself very well to the explanation of complex circuit schematics with complicated switching, such as those often encountered in telephone work. A basic schematic is projected on the blackboard without indicating the actual movable switching elements, and the instructor then draws them in. To show the flow of current or some important features of the circuit, he may go over parts of the schematic with colored chalk. He may use several colors to differentiate between parts of the circuit which perform different functions.

To a degree, similar results could be obtained by using a series of color slides, projected on the screen. This, however, is a rigid method, since nothing can be changed during the class presentation. In contrast, the new method offers almost unlimited flexibility, since numerous alternatives can be superimposed in various colors

and changed at will during the subsequent discussion. To answer students' questions, the instructor can expand or clarify his explanation by further use of this technique.

In another application of the method, a special coordinate system may be projected on the blackboard, e.g. semi-log or log-log scales. Thus a true frequency response curve can be drawn or reactance problem solved accurately. One of the most interesting applications would be to project the Smith Chart on the blackboard to teach students its use. Different colors can be used for different solutions, and then the projection can be switched off, leaving only the solutions.

In the teaching of architectural subjects, the method presents definite advantages. A photograph or a good drawing of a façade is projected on the blackboard. The instructor may evaluate certain features critically and draw his corrections over the picture; or he may indicate the historical development of a certain form.

In the field of mechanical and civil engineering, the method will undoubtedly find many applications as in the critical evaluation of a machine cross-section or of a basic bridge design. The instructor can correct in color the projection of the design shown on the blackboard; his comments are simultaneously drawn by the students in their notes or textbooks. For teaching tactics or strategy in military schools, the method offers interesting features since consecutive moves of armies, corps, or divisions can be easily superimposed on a map and the instructor's evaluation added. These are just a few examples of the use of this method, which has almost unlimited possibilities in teaching subjects for which slides and screen are now used.

The new method saves much of the instructor's time and saves the institution the money involved in making many slides. It has unusual flexibility in that it can be adapted to almost any field of engineering or the decorative arts and can be fitted to the needs of any individual classroom situation. It thus has possibilities for creating entirely new types of presentation of material.

FIFTH NUCLEAR CONGRESS—1959

The 1959 Nuclear Congress will be held in the Public Auditorium, Cleveland, Ohio, April 5–10, 1959. The Congress will be composed of four parts: the Nuclear Engineering and Science Conference, the Hot Laboratories and Equipment Conference, the Atomic Energy Management Conference, and the Atomfair, at which nuclear equipment will be on display. Theme of the Congress will be "For Mankind's Progress."

General information concerning the Congress is available from:

T. A. Marshall, Jr. (Congress Manager) or
L. K. Wheelock (Assistant Manager)
c/o Engineers Joint Council
29 West 39th Street
New York 18, New York

ASEE is one of the sponsoring groups for this Congress.

Candid Comments

THE SCIENTIST AND THE HUMANITIES PEOPLE

JOHN H. DISMANT

Assoc. Prof. Mining and Metallurgy
Texas Western College, El Paso

I would like to comment on Mr. William Geoffrey's discussion "Art and the Engineer" in the May 1958 issue. His concluding remark is, and I quote:

> The scientist of today must cultivate a sensitive eye for art and beauty. He must guard himself and guard us against the inhumanities.

It appears to me as a scientist and engineer that his remark would be much more to the point and a better solution of the implied problem had it read—The humanitarian of today must cultivate a sensitive eye for the art and beauty of science. He must guard himself and us against the inhumanity of divorcing science from life and human progress.

Earlier in this same article Mr. Geoffrey has shown a considerable depth of understanding in discussing the qualifications for an educated man. I again quote:

> The educated person is one who strives to be catholic in his tastes, not to the point of effete tolerance, but to the point of a full-bodied enjoyment of variety, curious of all the facets of the universe and all the diversities of mind that make us at the same time one and many. He must have knowledge and sensibility.
>
> The facts he has must be used as tools to improve understanding. The sensibility he has must be used to illumine not only his own interior but the interiors of others through a kind of reflection. The mind of the educated man is not just a reservoir, it is a constant, unceasing transformer of energy. But its most vital property is that it can look ahead. It is never static or stable, but unremittingly on the move, its energy produced by oscillation between faith and doubt.

I am heartily in agreement with Mr. Geoffrey as to what constitutes an educated person and strangely enough I am fully convinced that among the better scientists will be found the greater portion of people approaching these qualifications. My conviction arises not only from a wide variety of contacts but from the fact that the scientist or engineer is constantly seeking the truth about the world around us and by the very nature of his training is constantly reassessing all of the values he has found; furthermore, the scientist is somewhat removed from some of the major deterrents to the finding of truths, such things, for example, as petty politics, sensationalism, protocol and tradition.

All progress toward a more perfect life is on two lane streets. I therefore recommend to people interested in humanities that they use their energies to pull with the scientists rather than to oppose them. As a first step, let us overcome the false picture of what constitutes a scientist as he has been maligned by many so-called humanities people who represent the press and the movies. Science and engineering consist mostly of hard but exceedingly interesting work to those who are pursuing it, but it may appear to be uninteresting to those who do not see the whole problem or its potentials. For this reason a distorted

picture is usually presented to the general public, culminating with a disastrous but widely held view that scientists are not human. This misconception is further enhanced by the lawyers, bankers, accountants, business men, etc., who have the ultimate decision in many corporations. This management at times lacks the full humanistic picture but the scientist must concentrate on the factors they direct and at the time they direct, for they provide his livelihood; because of such factors the scientist may at times appear inhuman. If, however, the people directing the overall work have a reasonable appreciation of science and engineering then nearly all such misconceptions of the scientist will disappear.

The answer is not only to be sure that the scientist has an appreciation of the humanities, but conversely that the arts, humanities, business, etc., have a full appreciation of science. The capable scientist can best be compared with good artists, musicians, writers and other imaginative, constructive and visionary people. In fact, fundamentally there is not any wider separation between a good musical composer and a scientist than there is between a good musical composer and a sculptor. I know several scientists whose recreation is along artistic lines, and many of these with no small amount of merit in their hobby. Personally my hobby is philosophy. Can an appreciable number of the humanities people boast that their hobby is some phase of science?

Let us all start now to learn the opportunities for human happiness and development that scientists and humanities people can develop when working and looking upward together.

DEAN CHARLES W. BEESE OF PURDUE

Charles W. Beese, Dean of the Technical Extension Division at Purdue University, died on June 29 of a heart attack at his home in West Lafayette, Indiana.

Dean Beese had won widespread recognition for his work in technical education. In 1953 he was awarded the James H. McGraw Award for outstanding contributions to technical institute education, and he had long been active in the work of ASEE's Technical Institute Division. He had been a member of ASEE for twenty years, and he was active in other professional organizations.

Dean Beese had served as a member of the education committee of the President's Conference on Industrial Safety and was later chairman of the education committee of the Governor's Conference on Industrial Safety in Indiana. He was a member of an Engineering Education Mission to Japan in 1951 and a consultant on industrial management to the industries of Turin, Italy, in 1952.

Born at Des Moines, Iowa, in 1891, Dean Beese received the B.S. degree from Iowa State College in 1915, and the M.E. degree in 1923. He was a registered professional engineer in Indiana and Pennsylvania. He had been at Purdue since 1937.

Dean Beese is survived by Mrs. Beese, a daughter, Betty, and two brothers.

Candid Comments
FOR MORE EFFECTIVE TEACHING

EUGENE G. PARE

Professor of Mechanical Engineering
Washington State College, Pullman

The experienced college professor is unquestionably an expert teacher. Although he has had no formal training for this honored position, he has absorbed, perhaps by osmosis, all there is to know about teaching methods and the learning process. This he has accomplished by what might be called trial-and-error research, using as guinea pigs for several years a captive audience of students.

Yes, each professor is convinced that he has mastered the art of teaching. He is not sure that each of his colleagues is as competent as himself, for he has heard rumors to the effect that students avoid enrolling in sections taught by a certain professor whose presentation is dull or carelessly organized, whose enunciation is poor, or whose blackboard demonstration is difficult to decipher. Of course, the students who avoid his own classes do so not for the preceding reasons, but rather because they are the dull students who are reluctant to cope with the scholarly and rigorous treatment of the subject for which he believes himself renowned, rather than notorious.

Those less talented and less experienced than he undoubtedly need to learn a little more about teaching techniques. Thus, when an administrative official or perhaps a faculty committee, who have exhausted more timely topics such as the question of more convenient reserved parking space for the harassed professor, suggest that a special faculty committee be organized to study the problem of "More Effective Teaching," our man agrees that such a committee would be harmless and might even serve some useful purpose as long as no attempt is made to alter his own infallible techniques and procedures.

And so a committee is duly appointed. After some weeks of weighty deliberations, held at times when our professors were supposed to be teaching, the committee decides that it is not the quality of the teaching that needs improving; the problem, if any, might be directed at the competence of the student or possibly at the physical environment. It is suggested that admission requirements be raised and that a new admission director be employed; it is recommended that high school teachers be requested to teach their courses more thoroughly, that classroom lighting be improved, study facilities enlarged, *et cetera, et cetera, et cetera.*

When this inexhaustible area of research is exhausted, the committee directs its attention to more personal matters that could have some bearing on the improvement of instruction. Would not teaching effectiveness be enhanced if student assistants were provided to handle the tedious task of grading papers; would not teaching effectiveness be improved if class size could be cut from twenty-five to twenty-two? Would not a professor do a more effective job of teaching if his work load were cut from twelve to eight hours per week (as if a professor would have time to write on as trivial a subject as this if he were overworked)? But alas, for some dubious reason the administration has been contemplating an increase in teaching loads and class sizes to accommodate the expanding student body.

With this problem of increased enrollments confronting them, the committee decides that although they themselves are expert teachers by virtue of their long tenure in higher education, perhaps the newly-hired and inexperienced instructors might benefit by a limited exposure to teaching techniques in two or three pre-semester sessions conducted, of course, by one of their own self-taught teaching experts. The principles of teaching as expounded by the college Education Department could hardly be applicable to teaching at the college level, where it is necessary only that an instructor be a master of his subject.

The committee has done its job. It has, among other things, initiated a limited program that in a sense recognizes that at least the new instructor can benefit by some exposure to the art of teaching. (If we do not consider teaching to be an art, then we certainly degrade our profession.)

But has this committee done enough? Can a college recruit a recent graduate and with only limited guidance expect him to assume the responsibilities of a full teaching load? Or should the committee admit that the Education Department on campus knows something about teaching the novice to teach? Perhaps one of their following proposals, previously shelved, should be reconsidered:

1. A two- or three-week teacher training program preceding the beginning of classes, utilizing the best qualified staff from the fields of education, psychology, and pertinent subject-matter fields.
2. A training program planned for the full range of a new instructor's first semester of teaching, during which time he is assigned less than a full teaching load.

Who knows; if some such program is adopted, possibly we self-acknowledged experts might be encouraged to participate.

RUSSIAN SCIENTIFIC JOURNALS AVAILABLE IN ENGLISH

Approximately 60,000 pages a year of key Soviet scientific and technical journals are now available in English translation, according to the National Science Foundation. A compilation of translated Russian journals has been made by the Foundation's Office of Scientific Information giving the titles of the journals, the address from which they may be ordered, and the subscription price.

Support of these translations is provided by Government agencies—the National Science Foundation, the National Institutes of Health, the Office of Naval Research, and the Atomic Energy Commission—and by six commercial translating and publishing firms working without Government funds.

Foundation-supported translation projects are conducted by United States professional scientific societies and university groups which have chosen the Russian material to be translated and which have requested the financial support of the Foundation. These organizations administer their own projects and provide expert consultation to translators to help insure accuracy. The translations are sold on a subscription basis with the resulting income used to defray part of the costs of the projects.

ENGINEERING EDUCATORS BEFORE CONGRESSIONAL COMMITTEES

The following are excerpts from the statement of G. E. Arnold, Chairman, Engineering Manpower Commission of Engineers Joint Council, accompanied by Dr. Frederick C. Lindvall, President of ASEE 1957–58 and Chairman, Division of Engineering, California Institute of Technology, and Dr. Ralph A. Morgen, Director of Purdue Research Foundation and Vice President of ASEE for ECAC, before the Senate Committee on Labor and Public Welfare, March 3, 1958. Similar testimony was presented last spring to the Health and Science Subcommittee of the House Commerce Committee, and to the Subcommittee on Special Education of the House Committee on Education and Labor.

Membership of the United States Senate Committee on Labor and Public Welfare of the Eighty-Fifth Congress:

Lister Hill, Alabama, *Chairman*
James E. Murray, Montana
John F. Kennedy, Massachusetts
Pat McNamara, Michigan
Wayne Morse, Oregon
Strom Thurmond, South Carolina
Ralph Yarborough, Texas
H. Alexander Smith, New Jersey
Irving M. Ives, New York
William A. Purtell, Connecticut
Barry Goldwater, Arizona
Gordon Allott, Colorado
John Sherman Cooper, Kentucky

I am G. E. Arnold, Chairman of the Engineering Manpower Commission of Engineers Joint Council. EJC is a non-profit federation of 13 national engineering societies with a total membership of about 250,000. One of these organizations is the American Society for Engineering Education. Since the interest of the Committee is weighted to the educational aspects of the problems we face, we have with us the President of ASEE, Dr. F. C. Lindvall, who is also Chairman of the Division of Engineering at the California Institute of Technology, and Dr. Ralph A. Morgen of ASEE, who is Director at the Purdue Research Foundation. Prof. W. Leighton Collins, Secretary of ASEE, and Mr. W. T. Cavanaugh of Engineers Joint Council are also present. . . .

The engineering profession in the United States was surprised and disappointed by the reaction here and in many other parts of the Free World to the spectacular achievements of Russian technology last year—the events that have added a sense of urgency to the important work of this Committee. This reaction suddenly pictured the United States as fallen technologically from its role of world leadership. One of the reasons most frequently voiced for this supposed state of affairs was that we had been expending too great a proportion of our resources on consumer products and too little on national security considerations—the so-called "guns or butter" cliche.

We tried to indicate at the time the lack of realism of either of these two contentions. The fact is that we failed to precede the Russians into space simply because we did not decide—in time—to do it. This was a tremendous public relations coup by the Russians but certainly not a tech-

nological one. From the point of view of technology there is no reason why—if we work hard and use our resources wisely—we cannot have in the United States at the same time a rising standard of living and a national security position of ever-growing capacity and technical sophistication. Military technology and its counterparts are not mutually exclusive but rather part of the same fund of knowledge. They are very often, in terms of end products, complementary.

The other reason advanced for our "new position" was our educational lag. We have long recognized that we have in the United States very serious educational problems with not only the requirements which result from the Soviet challenge but also, and perhaps of equal importance, with the rapidly changing requirements of our economic and industrial structure. By focusing attention on these problems, the Russian successes actually did us a great service. But we feel that our analysis of where we are going has to begin with a realistic analysis of where we are. We think it important to keep these fundamental facts in mind because they insure that as our reaction to the Russian technological effort takes shape, we are moving currently from a position of over-all strength rather than weakness.

Since 1950, we have had in the United States an over-all dearth of qualified technical manpower of varying degrees of severity. Currently, we are experiencing a mild softening in over-all need, largely the result of defense cutbacks and stretch-outs which were begun almost a year ago. Most recently, the general economic pause has contributed a bit to this softening. But this is apparently a temporary phenomenon. All indications are that the situation will again tighten considerably as a result of increased national security expenditures and the long-run tremendous technological requirements which emerge from the changing equation of population growth and natural resources availability.

It should not be overlooked, however, that much private effort has been expended since 1950 to increase interest among properly qualified young people in engineering and scientific careers. The engineering and scientific professional groups have very strong and long-standing traditions of encouraging the interest of young people in these fields. As a result of these activities and certain more general trends toward college, undergraduate enrollments in engineering and most of the sciences are at an all time high. These forces already in motion, plus the enlarged college population just ahead, persuade us that there is no longer a numerical problem of undergraduate enrollment in these fields requiring extraordinary further stimulation. Nothing we do now could affect currently enrollment anyway. The die is cast in terms of graduates for the next four years. At the undergraduate level, we see great value in efforts to honor oustanding scholars such as are envisioned in the National Honors Program contained in the Bill introduced by Senator Flanders. However, any large undergraduate scholarship program would appear to be not only unnecessary but a misdirection of resources which could be used in educational areas where there are great demonstrable immediate needs.

As we see the educational problem, the great need is to insure that the talent that is and will be available in ever-increasing quantities is fully developed to meet the ever-increasing needs for highly qualified personnel in industry, government and education itself.

In terms of pre-college education, this obviously involves improved guidance and teaching, especially in mathematics and the sciences. We feel that the aids in these areas in the bills now before you can have a constructive impact. But these are long-range considerations with the pay-off period at least a decade away. Meanwhile, there are immediate problems in engineering education where solution would contribute much sooner not only to technical manpower resources for national security but to the crucial needs for highly qualified personnel in industry and in engineering education. The need is for greatly enlarged programs of graduate study in engineering.

We therefore strongly endorse those provisions in the various educational proposals before you which would provide greatly expanded opportunities for graduate education and enlarged fellowship and grants programs.

Lest we be misunderstood, let me summarize. There is no question that technical personnel, including engineers, scientists and technicians, will be required in increasing numbers and increasing quality in the years ahead, but there is every indication that large numbers of undergraduate students will be available. Therefore, it is our conviction that the major goals of Federal effort in education should be to aid in raising the overall quality of higher education through expanded graduate programs.

At this point, we come to the results of the efforts that the American Society for Engineering Education has expended during the past few years in the analysis of these problems and their educational requirements. I'd like therefore to defer now to Dr. Lindvall, President of ASEE.

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DR. LINDVALL: I am Frederick C. Lindvall, President of the American Society for Engineering Education and Chairman of the Division of Engineering at the California Institute of Technology, in which position I have served for the past thirteen years.

Engineering education is in real difficulty. At a time when industry has indisputable need for our best engineers, teaching demands have increased two-fold in quantity and in quality.

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Without an energetic effort to attract a larger fraction of young people in engineering just a normal growth of population would increase the engineering enrollment in our colleges and universities.

Technological trends demand that the scientific content and level of intellectual effort in our engineering work be increased. Industry is placing an increasing premium on graduate work in engineering. Graduate work is also the best possible preparation for those who are to enter the teaching profession. Teaching graduate students requires a greater faculty effort than for undergraduate students. Without doubt, graduate enrollment will increase faster in proportion to undergraduate enrollment. This further intensifies the demand not only for more engineering teachers, but also for teachers who have the background in the basic sciences and the engineering sciences to prepare students for the problems of tomorrow which today cannot be even stated.

The American Society for Engineering Education has been much concerned with the problems of the development of engineering faculties to meet the present and future demand for competent teachers. Dean Hazen of the Massachusetts Institute of Technology is Chairman of the Com-

mittee on the Development of Engineering Faculties. I will fill in some of the details of that Committee's findings of the needs and numbers and dollars to solve the engineering problem.

As an essential part of graduate work and indeed even to create the proper climate for undergraduate work in engineering, faculty and student research is a necessity. Without such research, students are less well motivated to learn, and faculties may stagnate in professional development.

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Modern engineering, as exemplified by our Explorer satellite, works in many of the areas of science which formerly were considered classical physics and chemistry. The demands for higher performance rocket fuels, for materials which can maintain their essential properties at extreme temperatures, for knowledge of atmospheric properties as missiles approach the outer atmosphere, force the engineer to investigate these frontiers of knowledge which a few years ago were blue sky but are today's reality. This means more engineers and better trained engineers, because knowledge of good engineering practice is not enough. New information must be sought and applied. This new information then must be translated into new designs and systems which, in turn, must be feasible and produceable, whether for a single test or in quantity. The engineering education of a generation ago is not adequate. Both greater breadth and greater depth are needed.

Engineering education also has a traditional handicap to overcome. It has been a natural expected thing for engineering students to seek their professional careers in industry, in the broad sense; it has not been, as it has in science, the pattern for the young engineer to go on to graduate school and to seek his professional career in academic work. We in engineering colleges must make teaching a vital career to our best young men and create in our graduate schools the climate of scholarship and research which has at least the intellectual challenge of industrial work, if not the financial reward.

Financial support in substantial amount is needed for some of our best young engineering graduates, so that they may continue in graduate school in preparation for a teaching career, without too great a sacrifice compared with attractive and immediate industrial employment.

With such graduate study, research support and facilities must be available for the student and to the faculty so that the proper environment for graduate study may exist and the professional development of the faculty and students can be assured. This means a marked increase in the amount of money available for fundamental research in engineering sciences, rather than development work, which is more properly the function of industry. . . .

Your earnest consideration of the needs for graduate work and research in engineering is most respectfully sought. We believe that these needs must be kept in sharp focus by specific identification in all legislative measures directed toward strengthening science and engineering. . . . The resources for educating the first-rate engineers and scientists so essential to a dynamic technological economy in industry show clear beginnings of deterioration. Fortunately, at the crucial juncture, nationally and internationally, our world competitors have given us a vital lead. They have shown us dramatically and forcefully that we face scientific and engineering competition of first quality in our contest for survival. . . . Persuaded

of the urgent need to plan for meeting the problems of technological education as they exist and can be foreseen for the next decade, the American Society for Engineering Education in 1956 began a comprehensive study of our human resources for engineering education—our students and, specifically, the faculties we must have to teach them. The study has had the support from the National Science Foundation, Philco Corporation, International Register, Leeds and Northrup Foundation and the Burroughs Foundation. This study now reports on the faculty needs of education during the next decade as foreseen by deans of 160 engineering colleges. The report conclusions are based on the deans' estimates of growing engineering enrollments. By 1967: 1. Undergraduate enrollments will increase by about 66 per cent to a total of about 515,000. 2. Graduate engineering enrollments for master's degrees will increase about 93 per cent to approximately 44,000. 3. Graduate engineering enrollments for doctorates will increase by about 115 per cent to approximately 6,500. These are conservative estimates. They were made before Sputnik I and so do not reflect recent growing emphasis on science and engineering, and they come only from existing engineering colleges, thus omitting institutions which will be granting engineering degrees in the next decade.

To teach these rapidly growing numbers of students, the engineering deans estimate that: 1. The number of engineering teachers must increase by about 76 per cent by 1976 to approximately 16,000. 2. To assure that good engineers are attracted to these positions, expenditures for faculty salaries must increase about 233 per cent to two hundred million dollars, while the numbers of educators increase by 76 per cent. And while the net increase in faculty by 1967 is estimated at 76 per cent, normal retirement and net turnover will make it necessary to include aproximately 9,600 new teachers into engineering colleges to achieve the net increase necessary. The quality of education depends critically upon the competence of our teachers. Already short-handed in many classrooms and laboratories, how can we plan for the many more science and engineering faculty we shall need by 1967? How can we assure that these will be first-rate teachers? Faced with this great need for new teachers, our engineering educators fear most deeply of all the deterioration in quality which will be inevitable if expediencies rather than first choice govern faculty appointments. Indeed subtle creeping compromise with quality faculty is already reported by many deans. . . . Allowed to continue, this deterioration will soon have an undeniable effect on the entire pattern of technological education in the United States. In 1956–57 engineering deans reported a total of about 9,800 budgeted engineering faculty positions, and only a little over 8,500 of these were adequately filled. The other 13 per cent were either vacant (7.5 per cent) or filled with temporary, part-time or unsatisfactory personnel (5.5 per cent). Many steps may be taken to assure an adequate supply of engineering teachers.

The source of most science and engineering teachers is full time graduate schools and an immediate sharp increase in graduate enrollments is necessary. But a doctorate requires about five years and we need teachers sooner. Furthermore, an increase in graduate enrollments will increase the burden of our present faculties, making our needs greater than the Committee's present estimates. And as an essential part of graduate education and faculty development, research

support and adequate facilities must increase markedly. We must use our engineering teachers more efficiently with larger classes, technical aids, non-professional assistants and other time-saving devices of every kind. Large modern facilities, a problem not touched by our study, will be most important and costly. Helping good students to finance their education, the principal focus of most of today's aid to education thinking, is likewise important as a means of increasing advanced degree enrollments and hence of increasing the supply of potential teachers.

We shall, of course, need to use all expedients within our power to recruit engineering teachers from the ranks of qualified graduate students. But facilities, financial support, graduate education, educational aids, recruitment all are meaningless if students find as their teachers only what is left after the cream of ability has been skimmed. One dean reports to the Committee, "In the last few weeks, I have talked to several young men about the possibilities of careers in teaching and the answers are very much alike. They just cannot see spending three more years of their lives without adequate earning power in order to prepare for a job which itself does not have adequate earning power."

Survival of American engineering education at a mere commonplace quality level a decade hence will require doubling our engineering faculty salary bill. But to compete, we need excellence and this will cost even more. We need to make careers in engineering teaching so attractive that we can now return to our faculties some of the first ranking engineers who originally chose other fields in the profession, so attractive that we may be sure of our power to compete for the really good teachers, the really skilled leaders, whose wisdom must be multiplied for future generations. Thank you, sir. Now Dr. Morgen will elaborate, unless you choose to ask questions at this time.

THE CHAIRMAN: Suppose you go ahead.

DR. MORGEN: I shall be glad to. My name is Ralph Morgen. I had thirteen years of industrial research before I went back into university teaching in 1938. Since 1938 I have been in engineering teaching and research at the universities with the exception of two years at the National Science Foundation from 1952 to 1954. Since 1954, I have been Director of the Purdue Research Foundation at Purdue University. I have been associated with the ECPD accrediting programs for the past fifteen years. I have been Chairman of the Committee on Education of the American Institute of Chemical Engineers and associated with the ECPD, which is the accrediting body. I am Vice President presently of the American Society for Engineering Education. I agree wholeheartedly with everything that has been said up to this point and I would like to simply amplify certain points and make them a little more clear.

Certainly the emphasis must be in the next few years on quality rather than on quantity. Dr. Lindvall mentioned that we will need, in the next ten years, 9,600 more staff members in our institutions of higher learning. It is interesting to note that the Ph.D.'s in engineering for the past five years total about 600 per year. So if all the 600 Ph.D.'s per year in the next ten years select teaching as their career we would still be short 50 per cent of the needs for engineering teachers.

THE CHAIRMAN: You are bound to have some attrition.

DR. MORGEN: That is, assuming that none go into industry. At present, 90

per cent go into industry and 10 per cent to the universities. So you can see that it is clearly a serious problem as far as engineering education is concerned. The question then is, what can we do to increase the number of Ph.D.'s in various engineering areas not only for the needs of industry and the country as a whole but also on the staffs of universities? I do not want to dwell on scholarships. I think that it has been covered enough. We do not have to get more undergraduates in the universities to study engineering. They are going to come. We must concentrate our real efforts in getting a larger percentage of engineering graduates to take graduate work and to assure their leadership by teaching engineering subjects in institutions of higher learning. I would like to point out that we need the top 25 per cent of the class for the teaching profession. That is the same top 25 per cent of the class for which industry is making such a play at the present time. . . . At the present moment, industry is offering a bachelor's degree graduate with no experience approximately $6,000 per year. In the normal course of events, if he does well in industry, he can expect to be earning approximately $8,000 at the end of four years. Let us make the assumption that the time to get a Ph.D. degree is approximately four years. So in that four-year period the student would have earned in industry approximately $28,000. The best that the university can offer at the present time is about $1,800 to $2,000 per year as a teaching assistant in the first year of graduate work. On that basis, the graduate student as a teaching assistant and possibly as a research assistant can earn somewhere between $10,000 or $15,000 in the period when the man out in industry would be earning at least $25,000. So the student as he graduates with his bachelor's degree naturally hesitates to enter the doctorate, for the simple fear that it will cost him approximately $15,000 to $20,000.

He can read the tables. They will show that in his professional rank he will make more than $15,000 to $20,000 more than he will lose in the four years. But he is about ready to get married. He cannot live on what he can get as a teaching assistant and be married. His wife would have to work. So we lose a large percentage of the students at this point purely on an economic basis.

What I would like to put forth as a thesis is that those grants that we give to the graduate students be given as a supplement to the ordinary teaching assistantships so that the students could be expected to earn somewhere between $3,000 and $4,000 a year. We estimate, at least in Purdue, that at that level a student and his wife can live. When children come along it gets rather complicated but they can get by. But the problem is twofold. The institutions of higher learning depend upon graduate students as teaching assistants to help carry the teaching load. If we give fellowships at a high enough level so that students are not required to do some teaching, there will be undesirable effects. The cost of higher education would go up very materially if we had to hire additional professors to take over the load which is now being carried by teaching assistants. There is no feasible way of getting those additional teaching staff people in the next ten years. . . . So any fellowships, any grants which are given to graduate students would be most desirable if they were combination fellowships or grants in which the teaching assistant's salary plus a grant would make a living wage for the student.

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THE CHAIRMAN: Doctor, let me ask this question before you leave this point, which you have very strongly made. I believe you said you were with the National Science Foundation for two years.

DR. MORGEN: Yes.

THE CHAIRMAN: What is the policy of the Foundation in connection with the very points you just made about the granting of a fellowship requiring that the recipient of that fellowship also engage in work as a teacher?

DR. MORGEN: I am very happy that you asked that question. The National Science Foundation as you know gives aid to graduate students in two different ways at the present time. One is the fellowship program and the other is as a research assistant through the grant program. The fellowship program at the present time has been limited to approximately two million dollars a year, and rightly so, because I consider this largely an advertising program to interest bright people in graduate work. Many more apply for these fellowships than receive them. Those who do not receive the fellowships then are put on an honorable mention list. That indicates to the universities throughout the country where these persons are available. Everyone of them, to my knowledge, who has been on an honorable mention list of the National Science Foundation has gotten help in the form of a teaching assistantship or some other thing. There was no need to increase the fellowship program beyond the present level.

There was one other point. The present fellowships in engineering are going to about ten or fifteen institutions. There are more than 67 institutions in the country that are giving Ph.D. programs in engineering. When you give a fellowship to the student, the student selects the "name" institution and I put the word "name" in quotes because he has heard about it, not because it is necessarily going to give him what he needs. So it would be most desirable if the fellowship programs could be broadened so that a large number would be available through the schools themselves, if the quality could be maintained, so that we would have these fellowships spread to 60 or 65 institutions rather than to 10 or 20 institutions.

Then the support to the grant program is coming to the students more in their second or third year of education. The need is more for support at the first year level to encourage students to go into graduate work. Does that answer your question, sir?

THE CHAIRMAN: It does indeed, sir.

DR. MORGEN: I just want to summarize very briefly and then I will be happy to answer any questions I can.

Unless we concentrate then on getting more qualified persons to enter the profession of teaching in engineering, all of the measures that we take will be futile. We need first support of graduate students in engineering at more than an assistant's level if we are going to attract the kind of people we want into the graduate student program.

Second, we need somehow more encouragement of those graduate students who stay in teaching as a profession. How we are going to raise the prestige of teaching, I do not know at this point, but that is as important as the money.

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THE CHAIRMAN: We have to educate. We the people have to have a real respect for our teachers, our educators and for the learning process, so to speak. Is that not true?

DR. MORGEN: That is correct. How we are going to accomplish it is by ever-lasting publicity, by prizes for people who do well intellectually, and

not in making dollars available. Our prizes, if you go back and check, are based on making money. What we need are prizes for intellectual achievement. We do not have contests for intellectual achievement. We have contests for sports and making money and contests for the most successful businessman, but not contests for the most effective teaching. I think we can do a lot with just plain advertising.

Somehow we must increase the prestige of the teaching profession, and a program, of course, which will help is that which Dr. Lindvall mentioned, the support of basic research in the engineering sciences by the various Federal agencies, research which will be financed at the institutions of higher learning.

Actually, we can increase the staff salaries in the universities by about 20 per cent to 30 per cent by increasing their academic yearly salaries, by support of research during the summer months plus the support of graduate students.

That is about all I have to say.

THE CHAIRMAN: Doctor, I was impressed by Mr. Arnold's statement in which he declared that it was his opinion that scholarships should not be granted. In the Bill which I introduced for Senator Yarborough and myself and a number of other senators, we based those scholarships on superiority in the interest of the students, seeking to challenge the parents, the people, and the students in the schools and seeking to give a new emphasis to what we might term "intellectual attainment." I wonder if scholarships on that basis would not attribute at least something to the very thing you are speaking about?

DR. MORGEN: I am in entire agreement. I would like to see scholarships on the basis of a prize award, not quantity of scholarships but a few which are offered as a prize so that they would be considered intellectual achievement. On that basis, I think they could do some good.

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THE CHAIRMAN: Of course, you realize, too, in our consideration, we have to think not only in terms of engineering, science, mathematics and foreign languages, but I am sure you gentlemen will agree that we have to think of the whole American scene, so to speak, that we need men strong in history, literature, cultural activities, and social sciences. So the scholarship program would have to contemplate not only the engineers, as important as they are, but the whole American scene. Is that not correct?

DR. MORGEN: That is correct, sir.

DR. LINDVALL: I would just like to add one thing. Scholarships are good as far as they go. We college people are very much concerned that a scholarship program alone would only add more difficulties in higher education and will not solve them.

THE CHAIRMAN: I understand. I might say that in the Bill which I had the honor to introduce for Senator Yarborough, myself and others, we did not stop at the scholarship phase. We also provided a loan program in what we termed a work study program. . . .

SENATOR YARBOROUGH: Mr. Chairman, I think there has been a very fine presentation of the problem of engineering education. I have no additional questions. I want to thank you gentlemen for the splendid amount of information you have given us in such compact form. I find there is no failure here in engineering education to communicate to others the ideas and facts that you have.

THE CHAIRMAN: Let me ask one other question, doctor. You spoke of

five years for the Ph.D. As I recall it, the Bills before Congress contemplate three years for graduate study. Should that be a five-year program?

DR. LINDVALL: In most schools, three years represents the minimum time after a bachelor's degree in which it is possible to get the Ph.D. but most graduate students are not that lucky. Something goes wrong with the research and more time is required.

Four years is much more nearly typical. Many take five years to do this, particularly if they are carrying a substantial teaching load to support themselves through their graduate work.

THE CHAIRMAN: Then you would recommend that the eligibility be five years rather than three years?

DR. LINDVALL: Yes.

DR. MORGEN: May I comment on one point that I think is a little confusing? If students were supported full time on fellowships for three calendar years, if they went through the summers, had no other duties except to graduate, a substantial number would complete in three years. We are questioning whether that is the most desirable procedure; whether in that period they might be better off doing part-time teaching and part-time research so that it would take them four years and they would still get the Ph.D. degree.

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THE CHAIRMAN: Let me ask you gentlemen this question and see if you have a comment. When Dr. von Braun was here, he made this statement: "From the defense point of view, I would like to make one observation which I think is rather cogent. I find, when it comes to engineers that, by and large, engineers graduating from American technical institutions are very capable specialists in a field that is narrower than what his European counterpart would be.

"We find that we can get excellent high frequency engineers from American universities and institutions of higher technical learning, or excellent aeronautical engineers who are excellent mathematicians, but we find it very difficult to find men, who, shall we say, at the same time have a reasonably good background in electronics and aeronautics and aeronautical engineering in fields like guided missiles, for example, where you simulate the behavior of a guided missile with electronic means although the missile in flight is subjected to aerodynamic forces. So you need people with the working understanding in both fields." Do you want to comment on that?

DR. LINDVALL: I would say "amen" to that in this sense, that the Society of Engineering Education is very much aware of the fact that we have tended to be too narrow in our engineering education, particularly our graduate education.

About two years ago, we published a report on evaluation of engineering education which emphasized the need for a broader base of science and a greater breadth in the education of our engineers, including those humanities that have been the practice in the past. We very much endorse the idea of having this breadth that will enable a man to move easily from one field of engineering to another.

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SENATOR YARBOROUGH: Do you think to give this greater quantum of training in the humanities and science and foreign languages that you might have to increase the time to five years for an undergraduate degree?

DR. LINDVALL: That is one way. The other way is to drop out the more traditional forms of engineering, which

has been done in a good many schools who have wished to retain the four-year pattern, and put into a five-year or a master's degree program some of the more professional material that otherwise would not have been given.

DR. MORGEN: May I add one point to that which I think has been overlooked in the discussion and is pertinent to the discussion that came earlier this morning? We must decide that at the end of the bachelor's level, we want the student to be at a level. In order to get at that level, he must be at a certain other level four years earlier. If he is not at that level four years earlier then we must have a pre-engineering year in the universities where he can get to that level.

That has been done successfully in about eight or ten institutions in the last few years, where if a student has a deficiency in mathematics or English or science, and he cannot get calculus by the end of the freshman year, then he stays a year and a half or two years in his freshman year. Then if he ends his sophomore year at the proper level, he can get his training in four years.

If we can make the high schools produce students who have the proper level at the freshman year for engineering then it can be done in four years. If they do not come in at the proper level, then it cannot be done in four years.

THE CHAIRMAN: I have here an article that appeared in the *New York Times*, February 27 last. It is captioned "Science is a Fetish the Chinese Use." It is the last of four articles on Communist China by W. A. Cole, Editor of Reuters, who recently returned from a visit to that country. The article is dated London, February 26. Among other things, it has this to say about Communist China: "Learning is no longer the prerogative of the limited few. Universities are crammed to their limits. They turn out young men and women burning to place China on equal technological footing with the Western World. Science is their fetish."

I am going to put that article in the *Record* at this point. You gentlemen made such a strong and excellent presentation here, I think this article belongs right after your fine and compelling testimony.

ENGINEERING GRAPHICS DIVISION MIDWINTER MEETING IN DETROIT

The Midwinter Meeting of the Engineering Graphics Division will be held January 21, 22, 23, at Wayne State University in Detroit. The theme will be Graphics for Tomorrow, and the meeting will be concerned primarily with three areas: teaching techniques in graphics, new horizons in graphics, and graphics as an engineering system or science.

Host Chairman of the meeting is Professor Ralph T. Northrup of Wayne State University's Department of Engineering Drawing.

ENGINEERING COLLEGE RESEARCH COUNCIL ANNUAL REPORT FOR 1957-1958

During the year 1957–1958, the Engineering College Research Council of the American Society for Engineering Education continued in a variety of ways to fulfill its functions of assisting and promoting engineering research in colleges and universities. The several ECRC committees were active within their respective fields and undertook or completed a number of important tasks and studies.

Committee on Relations with the Federal Government

During the year the Committee on Relations with the Federal Government, under the chairmanship of H. R. Warfield, devoted most of its efforts to studies and negotiations with the Federal Government in connection with the preparation and issuance of a new set of cost principles for all government agencies to be used in research contracts and grants from the Government to educational institutions. A first draft prepared by the Government's Interagency Committee, headed up by the Bureau of the Budget had been received in the spring of 1957 and arrangements had already been made for ECRC to cooperate with the American Council on Education and the National Federation of College and University Business Officers in representing the interests of educational institutions.

During the summer of 1957 the ECRC committee prepared and submitted a general commentary on the Government's draft of a statement of principles. Chairman Warfield and Dr. Ralph A. Morgen of Purdue were designated as ECRC representatives to work with representatives of the American Council and the Federation of Business Officers to prepare a combined commentary which was eventually presented to the Government's Interagency Committee during the fall.

Following the submission of the commentary, a university working group was established to endeavor to reconcile differences as to the set of cost principles with the Government's Interagency Committee. Representing ECRC on the university working group were Chairman Warfield and R. J. Woodrow. As a result of a number of joint sessions with the Government representatives, many problems were resolved. The full ECRC Committee on Contract Relations with the Federal Government met and endorsed the positions taken by the university working group. However, as the year drew to a close several issues of substantive importance still remained unresolved and a statement of differences with the last Government draft had been prepared and presented by the university working group. There still remained a hope that these differences could finally be reconciled by the deadline set by the Government of July 1, 1958 for issuance of the new principles.

In addition to efforts on cost principles, the Committee met with representatives of the Department of Defense and submitted comments with regard to a new section of the Armed Services Procurement Regulation covering contract clauses for cost reimbursement-type research and development contracts.

Committee on Relations with Industrial Research Agencies

The Committee on Relations with Industrial Research Agencies, under the chairmanship of C. A. Dunn, devoted its primary efforts during the year to the development of a pamphlet on the subject of "Research Relations Between Engineering Educational Institutions and Industrial Organizations." A draft of the pamphlet was completed by Chairman Dunn and R. G. Folsom, including chapters describing the type of research conducted in educational institutions and factors to be considered in sponsoring research at such institutions, types of agreements which can be employed, and details of research contracts between

engineering educational institutions and industrial organizations. A survey of current practice was made upon which to base the chapter on research contracts. It is anticipated that a final report in definitive form will be issued following the discussion of the draft at the session devoted to this subject at the annual meeting in Berkeley.

Committee on Research Administration

The Committee on Research Administration, under the chairmanship of H. W. Barlow, continued to concern itself with the various aspects of internal administration of research in engineering schools. The theme of stability in engineering college research programs was of primary interest and served as the topic for three papers presented at the ECRC Conference at the Annual Meeting.

Committee on Research Capabilities in Engineering Colleges

The Committee on Research Capabilities in Engineering Colleges, under the chairmanship of Eric A. Walker with R. H. Ramsey as Director of its Survey, completed its study and report surveying the research capabilities of engineering colleges, financed by a $40,000 grant from the National Science Foundation. Copies of the final report were distibuted at the Annual Meeting and the report itself served as the topic of the general session sponsored by ECRC. Among the many results of the survey covered by the report were the indication that the nation's engineering schools could, without increase in manpower, increase their contributions to the nation's engineering research by at least 30%; to make the most effective use of this latent capacity, between $10 million and $25 million would be necessary on an annual basis.

Awards Committees

The Committee on the Vincent Bendix Award, under the chairmanship of R. J. Martin, again received a number of outstanding nominations. This was the third year for presentation of the award by the American Society for Engineering Education with the sponsorship of the Engineering College Research Council assisted by the Bendix Aviation Corporation. Professor Hunter Rouse, Director of the Institute of Hydraulic Research, State University of Iowa, was named to receive the award in recognition of his leadership in engineering education through outstanding contributions to the advancement of engineering college research programs.

The Curtis W. McGraw Research Award Committee, under the chairmanship of J. R. Cudworth, also received a number of outstanding nominations for the award which was given in 1958 for the second time. Dean Cedomir M. Sliepcevich, Dean of Engineering at the University of Oklahoma, was named as the recipient of the award in recognition of his outstanding achievements as a young engineering college research worker.

Program Committee

The Program Committee, under the chairmanship of J. D. Ryder, arranged a full and interesting program for the national meeting. At the General Session, sponsored by ECRC, the theme "Research in the Engineering College" was supported by papers covering the Survey of Engineering Colleges Research Capabilities, the Role of the University and Industry, and the Role of Government.

The practice of holding an ECRC conference for Presidents, Institutional Representatives, Deans, and Directors of Research, initiated during the previous year, was continued. This year the theme was "Stability in Engineering College Research Program." It had been hoped that the negotiations with the Federal Government on cost principles for research contracts would have been completed and that a report on this subject could be presented; delays in arriving at a final resolution of the problems involved prevented the fulfillment of this objective.

A third ECRC-sponsored session was devoted to the theme of "Research Relations with Industry" with a university and industry panel discussing the draft

report of the Committee on Relations with Industrial Research Agencies. In addition, ECRC joined with the Graduate Studies Commission in sponsoring a session devoted to discussion of the final report on the graduate study project.

The pleasant custom of a joint dinner by ECRC and ECAC was again continued. The speaker was Dr. Simon Ramo, President of the Space Technology Laboratories, Division of Ramo-Wooldridge Corporation.

The Committee on Publications

During the year 1957 the Engineering College Review was published and distributed. A book of over 400 pages, it included summaries of the research policies, key research officers, summaries of all research projects, and research statistics for all member institutions of ECRC. A history of the ECRC and the ECRC-adopted research policy were also included. Over $100 million in engineering research for more than 7,000 individual research projects were reported.

Other Activities

During the fall of 1957 Federal limits on expenditures and appropriations, primarily within the Department of Defense, had serious effects upon research contracts with engineering colleges and created even graver fears with respect to the future of engineering research programs under contracts from the Department of Defense. Representations were made to the Assistant Secretary of Defense for Research and Engineering deploring the course being taken and urging that radical changes be made to counteract the damage done. At least in part as a result of these requests, with a major assist from Sputnik, most of the cancellations, terminations, and curtailments were eventually rescinded and research program support was restored.

During the year, the ECRC worked with the Educational Methods Division of ASEE in the interests of developing a possible project on research in educational methods. ECRC also cooperated with the Graduate Studies Commission in connection with the issuance of the report of the Graduate Studies Project.

The committee for President Eisenhower's Conference on Technical and Distribution Research for the Benefit of Small Business called upon the chairman of ECRC to participate in the organization of the conference which was held during the fall of 1957; a number of representatives from ECRC institutions attended. The chairman also participated in the conference sponsored by the National Science Foundation covering research and development and its impact on the economy.

Consistent with past practice, the chairman of ECRC normally serves as the official representative of ASEE to the Division of Engineering and Industrial Research of the National Research Council. During the past year the National Research Council met in a single body for the first time in its history for the purpose of considering aspects of science of mutual interest to the several divisions of the Council. Research and education in science and engineering were emphasized in the meeting.

The chairman also served during the year as the member from ASEE on the Board of Directors and Executive Committee of Engineers' Joint Council.

Nominations and Elections

The Nominating Committee under the chairmanship of H. K. Work duly presented its recommendations for officers for the following year. By vote of the institutional representatives of ECRC, the following were elected:

Chairman—K. I. Wendt
Vice-Chairman—H. W. Barlow
Directors—H. B. Gotaas
John C. Calhoun

New Members

Brown University joined ECRC as a new member during the year.

Respectfully presented,
RAYMOND J. WOODROW,
Chairman

June 10, 1958

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ASTM–ASEE Symposium on Teaching of Materials (ad hoc): Glenn Murphy, *Chairman* of ASEE group, R. M. King, L. P. Mains, K. B. Woods

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Curtis W. McGraw Research Award: (See ECRC for Committee personnel)

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Division Activities—General: Glenn Murphy, *Chairman*, Iowa State College, Ames, Ia.; Committee members are chairmen and General Council Representatives of the following Divisions: Cooperative Engineering Education, Educational Methods, Evening Engineering Education, Graduate Studies, Relations with Industry, Technical Institute; and Chairmen of the following Committees: Ethics, Graduate Study Project, YET Study Committee (*ad hoc*); and Young Engineering Teachers

Division Activities—Instructional and Curricula: E. C. Easton, *Chairman*, Rutgers University, New Brunswick, N. J.; Committee members are chairmen and General Council Representatives of the following Divisions: Aeronautical, Agricultural, Architectural, Chemical, Civil, Electrical, Engineering Drawing, Engineering Economy, English, Humanistic-Social, Industrial Engineering, Mathematics, Mechanical, Mechanics, Mineral, Physics, and Chairmen of the following Committees: Engineering School Libraries, Nuclear Committee

EJC Study (ad hoc): J. H. Davis, *Chairman*, Stevens Institute of Technology, Hoboken, N. J.; W. T. Alexander, H. H. Armsby, W. L. McCabe, C. W. Muhlenbruch, K. F. Wendt, R. J. Woodrow

Engineering Education Exchange Mission to Russia (ad hoc): F. C. Lindvall, *Chairman*, California Institute of Technology, Pasadena, Cal.; W. L. Everitt, N. A. Hall

Engineering School Libraries: Jeanette Poor, *Chairman*, Cornell University, Ithaca, N. Y.; R. E. Betts, Marguerite Chamberlain, D. M. Crosland, Madeleine Gibson, A. R. Krull, Pearl G. Lewis, R. H. Moody, E. C. McClintock, Jr., J. H. Moriarty, Mary F. Pinches, I. A. Tumbleson

Ethics: W. W. Burton, *Chairman*, Minnesota Mining and Manufacturing Co., St. Paul, Minn.; F. T. Agthe, F. L. Cason, N. A. Christensen, C. S. Crouse, J. D. Davis, C. A. Dunn, P. G. Ellis, R. A. Emerson, J. W. Graham, Jr., L. Helander, E. F. Obert, S. P. Olmsted, R. L. Peurifoy, R. E. Swift

Financial Policy: R. J. Woodrow, *Chairman*, Princeton University, Princeton, N. J.; M. M. Boring, C. C. Chambers, Thorndike Saville, W. C. White, W. L. Collins, *ex officio*, John Gammell, *ex officio*

George Westinghouse Award: E. F. Obert, *Chairman*, University of Wisconsin, Madison, Wis.; G. N. Cox

(1959), T. H. Evans (1961), W. K. LeBold (1960), E. J. Lindahl (1961), G. A. Marston (1959), W. M. Rohsenow (1962), D. W. Ver Planck (1962), G. D. Lobingier, *ex officio*

Honorary Membership: G. W. Farnham, *Chairman*, The Ronald Press, New York City, N. Y. (1960); W. B. Boast (1959), A. B. Bronwell (1959), M. M. Boring (1960), E. L. Grant (1960), L. E. Grinter (1959), W. D. Jordan (1961), F. C. Lindvall (1961), E. W. Schilling (1961)

Industrial Fellowship: M. M. Boring, *Chairman*, Scotia, N. Y. (1961); T. W. Bonner (1960), C. M. Burrill (1961), M. E. Forsman (1960), P. F. Keim (1961), S. S. Kistler (1959), W. A. Lewis (1960), R. J. Martin (1961), R. A. Morgen (1959), J. F. Downie Smith (1960), H. E. Wessman (1959), H. P. Wile (1959)

Industrial Membership: W. D. McIlvaine, Jr., *Chairman*, University of Michigan, Ann Arbor, Mich.; F. E. Allen, B. H. Amstead, John Avery, B. C. Baker, Merl Baker, H. R. Bintzer, B. C. Boulton, B. B. Bright, W. Leighton Collins, R. O. Darling, H. W. Gouldthorpe, H. E. Heath, W. G. Ireson, M. S. Ketchum, G. D. Lobingier, H. E. McCallick, A. D. Preston, D. L. Pyke, C. E. Schaffner, C. Wandmacher, E. W. Boehne

International Relations: (See ECAC for Committee personnel)

James H. McGraw Technical Institute Award: R. Warren Marsh, *Chairman*, Erie County Technical Institute, Buffalo, N. Y. (1960); G. Ross Henninger (1961), C. S. Jones (1960), D. C. Metz (1959), K. R. Miller (1959), M. W. Roney (1961), A. Ray Sims (1961), K. L. Holderman, *ex officio*

Judging of the YET Paper Contest: Margaret D. Blickle, *Chairman*, Ohio State University, Columbus, Ohio; S. W. Chapman, W. B. Snow

Lamme Award: J. H. Sams, *Chairman*, Clemson College, Clemson, S. C. (1959); R. S. Burington (1961), J. C. Calhoun (1961), R. E. Fadum (1960), H. B. Gotaas (1962), E. D. Howe (1959), M. R. Lohmann (1962), D. H. Pletta (1962), J. T. Rettaliata (1960), R. L. Sweigert (1961) G. A. Rosselot (1960)

Loss of Faculty to Industry (ad hoc): A. R. Hellwarth, *Chairman*, Detroit Edison Co., Detroit, Mich.; L. R. Baker, M. M. Boring, D. S. Bridgman, H. L. Hazen, J. Stuart Johnson, L. H. Lamouria, D. L. Pyke, R. W. Van Houten

Manpower: (See ECAC for Committee personnel)

Military Affairs: (See ECAC for Committee personnel)

National Legislation: H. K. Work, *Chairman*, New York University, New York, N. Y. (1959); T. S. Crawford (1960), J. C. Elgin (1961), Walter Hartung (1960), H. Meyerhoff (1959), R. A. Morgen (1961), Paul Robbins (1959), W. T. Cavanaugh (1959)

Nominating Committee: M. M. Boring, *Chairman*, Scotia, N. Y.; V. J. Blum, H. L. Bowman, G. W. Bradshaw, E. C. Clark, D. W. Dutton, W. L. Everitt, W. L. Forstall, E. K. Hamlen, J. O. Hougen, F. C. Lindvall, E. F. Littleton, S. P. Olmsted, Haim Reingold, K. W. Riddle, R. J. Seeger, Samuel Seely, L. Z. Seltzer, F. L. Singer, J. F. D. Smith, K. O. Werwath, D. E. Whelan, Jr.

Nominating—ECAC: (See ECAC for Committee personnel)

Nominating—ECRC: (See ECRC for Committee personnel)

Nuclear: R. W. Moulton, *Chairman*, University of Washington, Seattle, Wash.; H. R. Beatty, C. F. Bonilla, L. B. Borst, W. H. Crew, C. E. Dry-

den, H. J. Gomberg, H. Isbin, G. D. Lobingier, Harold Lurie, R. J. Martin, L. V. McLean, Glenn Murphy, F. E. Myers, R. A. Patterson, D. S. Roberts, C. O. Smith, E. A. Trabant, M. W. White

Planning: S. C. Hollister, *Chairman*, Cornell University, Ithaca, N. Y. (1959); H. R. Bintzer (1960), A. B. Bronwell (1959), C. A. Brown (1960), D. C. Drucker (1961), L. E. Grinter (1959), F. C. Lindvall (1961), B. R. Teare, Jr., (1959), E. A. Walker (1959)

Program—ECRC: (See ECRC for Committee personnel)

Publications: W. Leighton Collins, *Chairman*, University of Illinois, Urbana, Ill.; R. F. Bitner, P. T. Bryant, W. L. Everitt, W. C. Laity, M. E. Van Valkenberg, H. E. Wessman

Publications—ECRC: (See ECRC for Committee personnel)

Public Information: J. I. Mattill, *Chairman*, Massachusetts Institute of Technology, Cambridge Mass.; Irving Blumenfeld, John Bolton, H. G. Botset, P. T. Bryant, W. J. Cavanaugh, G. U. Cleeton, C. C. Hall, Stanley March, G. Carleton Pearl, G. A. Speers, Robert Wycoff

Relations with Federal Government: (See ECRC for Committee personnel)

Relations with Industrial Research Agencies: (See ECRC for Committee personnel)

Relations with NSF (ad hoc): R. H. Roy, *Chairman*, Johns Hopkins University, Baltimore, Md.: G. B. Carson, Carl Chambers, R. A. Morgen, Gene Nordby

Research Administration: (See ECRC for Committee personnel)

Research Capabilities in Engineering Colleges: (See ECRC for Committee personnel)

Secondary Schools: (See ECAC for Committee personnel)

Sections and Branches—*Eastern:* R. W. Van Houten, *Chairman*, Newark College of Engineering, Newark, N. J.; Committee Members: Chairmen and General Council Representatives of the following Sections: Allegheny, Illinois-Indiana, Michigan, Middle Atlantic, National Capital Area, New England, Ohio, Southeastern, Upper New York-Ontario; and Chairmen of the following Branches: University of Alabama, Clarkson College, University of Detroit, University of Florida, University of Illinois, Navy Pier, Chicago, Illinois, University of Maine, North Carolina State College, Northeastern University, Purdue University, University of Tennessee

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Selection and Guidance: (See ECAC for Committee personnel)

Technical Institute Education Committee: S. C. Hollister, *Chairman*, Cornell University, Ithaca, N. Y.; M. R. Graney, Jeanne Miller, L. F. Smith, B. C. Boulton

National Survey of Technical Institute Education: K. L. Holderman, *Chairman*, Pennsylvania State University, University Park, Pa.; H. R. Beatty, M. M. Boring, C. J. Freund, G. A. Gullette, G. R. Henninger, R. L. Shurter, L. F. Smith

Textile Engineering: M. J. Lydon, *Chairman*, Lowell Technological Institute, Lowell, Mass.; C. L. Adams, Stanley Backer, H. A. Dickert, C. F. Edlund, R. K. Flege, W. J. Hamburger, M. E. Heard, G. E. Hopkins, L. A. Runton, E. P. Stevenson, J. L. Taylor

To Study Accreditation by Individual States (ad hoc): (See ECAC for Committee personnel)

Vincent Bendix Award: (See ECRC for Committee personnel)

Young Engineering Teachers: J. G. Richter, *Chairman*, Pennsylvania State University; J. H. Weinstein, L. Bryce Andersen, T. I. Lyon, T. H. Rockwell, J. M. Moore, Barbara C. Billings

YET Study (ad hoc): S. H. Pierce *Chairman*, University of Illinois, Urbana, Ill.; R. M. Boarts, L. D. Conta, V. L. Doughtie, E. D. Howe, J. G. Richter, C. R. Vail

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A Preliminary List

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(Ad Hoc) Committee to Study Accreditation by Individual States: E. C. Easton, Rutgers University, *Chairman*
Manpower: D. L. Pyke, Ramo-Wooldridge Corp., Los Angeles, Calif., *Chairman*
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ECRC Officers, 1958–59

A Preliminary List

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H. W. Barlow, *Vice Chairman*, State College of Washington, Pullman, Wash.
Renato Contini, *Secretary*, New York University, New York, N. Y.
Directors: J. C. Calhoun (1961), A. & M. College of Texas, College Station, Texas; C. C. Chambers (1960), University of Pennsylvania, Philadelphia, Pa.; J. R. Cudworth, (1959), University of Alabama, University, Ala.; C. A. Dunn (1960), Oklahoma State University, Stillwater, Okla.; H. B. Gotaas (1961), Northwestern University, Evanston, Ill.; J. D. Ryder (1959), Michigan State University, East Lansing, Mich.

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Curtis W. McGraw Award: W. J. Seeley, *Chairman*, Duke University; J. R. Cudworth, University of Alabama; B. G. Elliott, University of Wisconsin; R. E. Fadum, North Carolina State College; M. E. Forsman, University of Florida; George Gerard, New York University; E. E. Litkenhous, Vanderbilt University

Vincent Bendix Award: L. H. Johnson, *Chairman*, Tulane University; A. B. Bronwell, Worcester Polytechnic Institute; F. L. Foster, Massachusetts Institute of Technology; R. J. Martin, University of Illinois; J. H. Rushton, Purdue University; J. D. Ryder, Michigan State University; M. A. Williamson, Pennsylvania State University

Research Capabilities in Engineering Colleges: E. A. Walker, *Chairman*, Pennsylvania State University; C. A. Dunn, Oklahoma State University; R. A. Morgan, University of Wyoming; R. H. Ramsey, Pennsylvania State University; R. J. Woodrow, Princeton University; H. K. Work, New York University

Nominating Committee: R. J, Woodrow, *Chairman*, Princeton University; F. C. Lindvall, California Institute of Technology; H. K. Work, New York University

Publications: Renato Contini, *Chairman*, New York University; K. F. Wendt, University of Wisconsin; H. K. Work, New York University

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Representative: Jerry F. Gleason, Jr., Assistant Employment Manager

The Dow Chemical Company Texas Division, Freeport, Texas
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Representative: T. W. Schroeder, Chief Electrical Engineer

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Illinois Bell Telephone Company, 212 West Washington Street, Chicago 6, Illinois
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Representative: A. L. Wilson, Manager of Personnel Development Dept.
Texas Instruments Incorporated, 6000 Lemmon Avenue, Dallas 9, Texas
Representative: Mr. Robert E. Houston, Personnel Director Apparatus Division
Iowa-Illinois Gas and Electric Company, 206 East Second Street, Davenport, Iowa
Representative: E. F. Miller, Manager, Electric Transmission & Distribution Dept.

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Ward School of Electronics, 44 Niles Street, Hartford 5, Connecticut
Alan S. Wilson, President
Amarillo College, Amarillo, Texas
Joseph M. Ray, President
Chico State College, Chico, California
H. M. Adams, Executive Dean

NEW INDIVIDUAL MEMBERS

As of June 10, 1958

ENO, RICHARD SCORSE, Associate Professor, New York State Agricultural and Technical Institute, Canton, N. Y. Irving Gordon, Irwin Wladaver. Tech. Inst. Div.

HOWARD, ROBERT T., Associate Professor of General Engineering, University of Kansas City, Kansas City, Mo. B. Alden Thresher, Melford E. Monsees. Mech. & Materials.

MEYER, JOHN W., Instructor in Engineering Drawing, Chicago City Junior College, Wilson Branch, Chicago, Ill. Lumir P. Brazda, Lawrence E. Olsen. Engr. Drawing; I. E.

MORSE, ROBERT KENNETH, Assistant Professor of Civil Engineering, Bradley University, Peoria, Ill. H. Blickensderfer, M. G. Abegg. C. E.

PAUL, STANLEY L., Instructor in Civil Engineering, University of Illinois, Urbana, Ill. David A. Day, William J. Hall. C. E.; Mech. & Materials.

PITTS, CHARLES RODNEY, Specialist-Education & Training, General Electric Company, Schenectady, N. Y. W. H. Branch, Carroll F. Terwilliger. Admin. Indus.

SANER, H. ALBERT, Associate Professor of Chemical Engineering, Montana State College, Bozeman, Mont. Lewis G. Mayfield, E. W. Schilling. Chem. E.

SIMMANG, CLIFFORD M., Head of Mechanical Engineering Department, The Agricultural & Mechanical College of Texas, College Station, Tex. Edwin S. Holdredge, C. W. Crawford. M E.; Physics.

THATCHER, CHARLES M., Assistant Professor of Chemical & Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. Edwin H. Young, Donald L. Katz. Chem. E.

1059 new members fiscal year 1957–1958

As of July 31, 1958

BAHAR, LEON Y., Instructor in Mechanics, Lehigh University, Bethlehem, Pa. J. B. Hartman, F. P. Beer. Mech. & Mat.; M. E.

BENT, RALPH D., Coordinator of Training, Northrop Aeronautical Institute, Inglewood 1, Calif. C. T. Reid, H. W. Hartley.

BIEHL, ARTHUR T., Lecturer, Mechanical Engineering, University of California, Berkeley, Calif. H. W. Iverson, E. D. Howe. M. E.; Phys.

BIRINGER, PAUL P., Assistant Professor of Electrical Engineering, University of Toronto, Toronto 5, Ontario, Can. A. J. Kravetz, P. E. Burke. E. E.; Math.

BONNEY, DONALD T., Professor of Chemical Engineering, University of Maryland, College Park, Md. W. J. Huff, W. A. Pennington. Ch. E.; Min. Tech.

BOWMAN, JOHN R., Associate Dean and Professor of Science Engineering, Technical Institute, Northwestern University, Evanston, Ill. W. F. Stevens, A. B. Cambel. A. E.; Math.

BOYCE, DANIEL S., Lecturer in Agricultural Engineering, University of Puerto Rico, Mayaguez, P. R. J. H. Rodriguez-Arias, F. Gonzales-Mandry. Agr. E.

CARROLL, RAYMOND E., Director of Engineering, Industry Program of the College, University of Michigan, Ann Arbor, Mich. W. D. McIlvaine, J. G. Young. Admin. Educ.; M. E.

COBB, PRUITT B., College Relations Representative, Chance Vought Aircraft, Dallas, Tex. C. A. Besio, R. S. Stiff. Admin. Ind.

COMPARIN, ROBERT A., Instructor in Mechanical Engineering, Purdue University, Lafayette, Ind. T. B. Jefferson, O. W. Witzell. M. E.

CONROY, GRAHAM P., Laboratory Technician, Theoretical Physics Group, University of California Radiation Laboratory, Berkeley, Calif. P. F. Keim, H. W. Iversen. Hum.-Soc.; Phys.

COURTICE, HAROLD A., Professor of Electrical Engineering, University of Toronto, Toronto, Ontario, Can. G. F. Tracy, J. M. Ham. E. E.

DAVIDSON, BRUCE M., Assistant Dean of Engineering, University of Wisconsin, Madison, Wis. H. A. Kallsen, J. G. Woodburn. Admin. Educ.; C. E.

DAVIS, CHESTER L., Associate Professor of Mathematics and Engineering Mechanics, Tri-State College, Angola, Ind. P. A. Nurnberger, J. G. Radcliffe.

DERE, JOHN R., P. O. Box 3529 Rincow Annex, San Francisco, Calif. J. S. Campbell, J. L. Meriam. Gen. Engr.

DUNCAN, WILLIAM B., Instructor in Architecture, School of Engineering and Architecture, University of Kansas, Lawrence, Kansas. K. Deemer, W. Strode.

EAGLETON, LEE C., Associate Professor of Chemical Engineering, University of Pennsylvania, Philadelphia, Pa. R. W. Houston, M. C. Molstad. Ch. E.; Math.

EGERMEIER, ROBERT P., Assistant Professor of Mechanical Engineering, New Mexico Agricultural and Mechanical Arts College, State College, New Mex. J. P. Morgan, M. A. Thomas. M. E.; Mech. & Mat.

EMCH, PAUL I., Manager, Recruiting, Linde Company, Division of Union Carbide Corporation, New York, N. Y. C. J. Metz, V. O. Davis. Admin. Ind.; Chem.

EPPERS, WILLIAM C., JR., Assistant Professor of Electrical Engineering, Air Force Institute of Technology, Wright Patterson Air Force Base, Ohio. K. H. Ropen, V. S. Haneman, Jr. E. E.; Phys.

ESTCOURT, VIVIAN F., General Superintendent of Steam Generation, Pacific Gas and Electric Company, San Francisco 6, Calif. W. E. Reaser, F. T. Lewis. Admin. Ind.

EWELL, RAYMOND, Vice-Chancellor for Research, University of Buffalo, Buffalo, N. Y. F. P. Fischer, R. K. Smith. Admin. Educ.; Ch. E.

FABRYCKY, WOLTER J., Instructor in Industrial Engineering, University of Arkansas, Fayetteville, Ark. J. W. Wilkes, C. W. Oxford. Ind. E.; E. Drawing.

FOK, THOMAS D. Y., Associate Professor of Civil Engineering, Youngstown University, Youngstown, Ohio. T. E. Stelson, Tung Au. C. E.

GLAVIN, EDMOND J., Instructor in Civil Engineering, Clarkson College of Technology, Potsdam, N. Y. R. A. Wyant, E. McHugh. C. E.; Tech. Inst.

GOVIER, JOHN P., Associate Professor of Petroleum Engineering, School of

Mines and Metallurgy, University of Missouri, Rolla, Mo. C. L. Wilson, G. B. Clark. Min. Tech.; Math.

GREINER, RICHARD A., Assistant Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. W. B. Swift, R. W. Greer.

GROW, THOMAS A., Associate Professor of Civil Engineering, University of Massachusetts, Amherst, Mass. G. A. Marston, A. G. Sharp. C. E.

HAISS, GUNTHER W., Assistant Director of Education, American Technical Institute, Akron, Ohio. F. A. Flannery, T. J. Rung.

HERSHFIELD, CHARLES, Assistant Professor of Civil Engineering, University of Toronto, Toronto, Ontario, Can. A. J. Kravetz, P. E. Burke. C. E.

HESSLER, WILLIAM C., Instructor in Engineering Drafting, Henry Ford Community College, Royal Oak, Mich. R. Kollin, Jr., J. H. Ringelspaugh. Tech. Inst.; Engr. Drawing.

HORNING, DON O., Research Engineering and Lecturer of Engineering, University of California, Berkeley, Calif. P. H. McGauhey, G. H. Backer. Admin. Educ.; M. E.

IIJIMA, KEN'ICHI, Professor of Electrical Engineering, Yokohama National University, Ohkamachi, Yokohama, Japan. I. Koga, M. Oyama. E. E.

JENDRYNSKI, H. JOSEPH, Development Engineer, Solid Rocket Development, Aerojet-General Corporation, Rancho Cordova, Calif. J. S. Campbell, P. F. Keim. Adm. Ind.; Engr. Econ.

JOHNSTON, THEODORE J., School Relations Supervisor, Boeing Airplane Company, Seattle, Wash. J. H. Avery, J. W. Souther. Adm. Ind.

KAZI, AFZAL M., Assistant Professor of Mechanics, College of Engineering, Lahore, West Pakistan. R. J. Roark, G. W. Washa. Mech. & Mat.; Math.

KINDLER, HERBERT S., Director, Technical and Educational Services, Instrument Society of America, Pittsburgh 22, Pa. D. J. Weil, L. E. Slater. Admin. Educ.; Tech. Inst.

LEHMANN, WILLIAM L., Head, Physics Department, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio. G. R. Graetzer, D. W. Brauer. Phys.; Math.

LEONARD, ROY, JR., Assistant Professor of Civil Engineering, University of Delaware, Newark, Del. T. W. Brockenbrough, R. W. Jones. C. E.

LIU, CHANG K., Associate Professor of Mechanical Engineering, University of Alabama, University, Ala. W. K. Rey, J. R. Cudworth. M. E.; Mech. & Mat.

LYNN, ROBERT M., Instructor of Engineering, Technology Division, Embry Riddle Aeronautical Institute, Miami, Fla. T. J. Rung, R. M. Williams.

MARTIN, HAROLD C., Professor and Chairman of Aeronautical Engineering, University of Washington, Seattle, Wash. R. B. Von Horn, B. T. McMinn. Aero. & Aero. Engr.

MELLINGER, ROBERT L., Assistant Research Sociologist, Department of Engineering, University of California, Los Angeles 24, Calif. R. R. O'Neill, E. E. Dorsey. Hum.-Soc.

MICHAEL, BROTHER AQUINAS, Instructor in Electrical Engineering, Manhattan College, New York, N. Y. Brother A. Leo, Brother J. Elliott. E. E.

MCCONNELL, ROBERT K., Assistant Professor of Mathematics, University of Rhode Island, Kingston, R. I. J. R. K. Stauffer, G. B. Haggerty. Math.; Hum.-Soc.

MCKAY, ISABEL, President, Embry-Riddle Aeronautical Institute, Miami, Fla. L. D. Carlton, H. W. Hartley.

O'LEARY, FRANCIS B., Assistant Professor and Librarian, Librarian Institute of Technol., University of Minnesota, Minneapolis, Minn. S. S. Barich, E. W. Johnson. Libr.; Gen. Engineering.

OSGOOD, ELMER C., Professor of Civil Engineering, University of Massachusetts, Amherst, Mass. W. W. Boyer, A. G. Sharp. C. E.; Arch. Engr.

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